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ELECTRICITY
A PRACTICAL TRADE JOURNAL
12, LUDGATE HILL, LONDON, E.C.

No. 1574.—Vol. XXXV. FRIDAY, JANUARY 7, 1921. Price Threepence.

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DEVELOPMENTS IN PRINTING TELEGRAPHS AND TELEPHONE REPEATERS.

Leading Features of the Latest Western Electric Equipment.

The Western Electric Co., Ltd., has recently installed in its offices at 62, Finsbury Pavement, E.C., typical equipments of its latest printing telegraph apparatus and telephone repeaters of the audion type. It is impossible in short compass to do justice to either of these developments, but the following notes, based on our own observations and on explanations afforded personally by engineers on the Company's staff will make clear the principal features of the new equipments and demonstrate their enormous commercial utility.

The W.E. Start-Stop Printing Telegraph.—The Western Electric multiplex printing telegraph, based on the Baudot system but possessing considerable advantages over the latter, is capable of handling simultaneously four messages in each direction. About 50 per cent. of the Western Union Telegraph Company's traffic is carried by this system. The "start-stop" printing telegraph, first to be described, uses the same code as the multiplex system. One message can be sent in each direction at once, and the apparatus, though simpler than the multiplex equipment, uses only components which are common to the latter.

The low frequency impulses used with the start-stop apparatus can be superimposed upon telephone currents without interfering appreciably with the latter. Also, the start-stop apparatus can be associated with the multiplex system and thus makes it possible for outlying towns on light-traffic lines to communicate directly with a distant city through a multiplex line terminating in a neighbouring centre. For instance, Fig. 1 represents diagrammatically a quadruplex duplex circuit between stations A

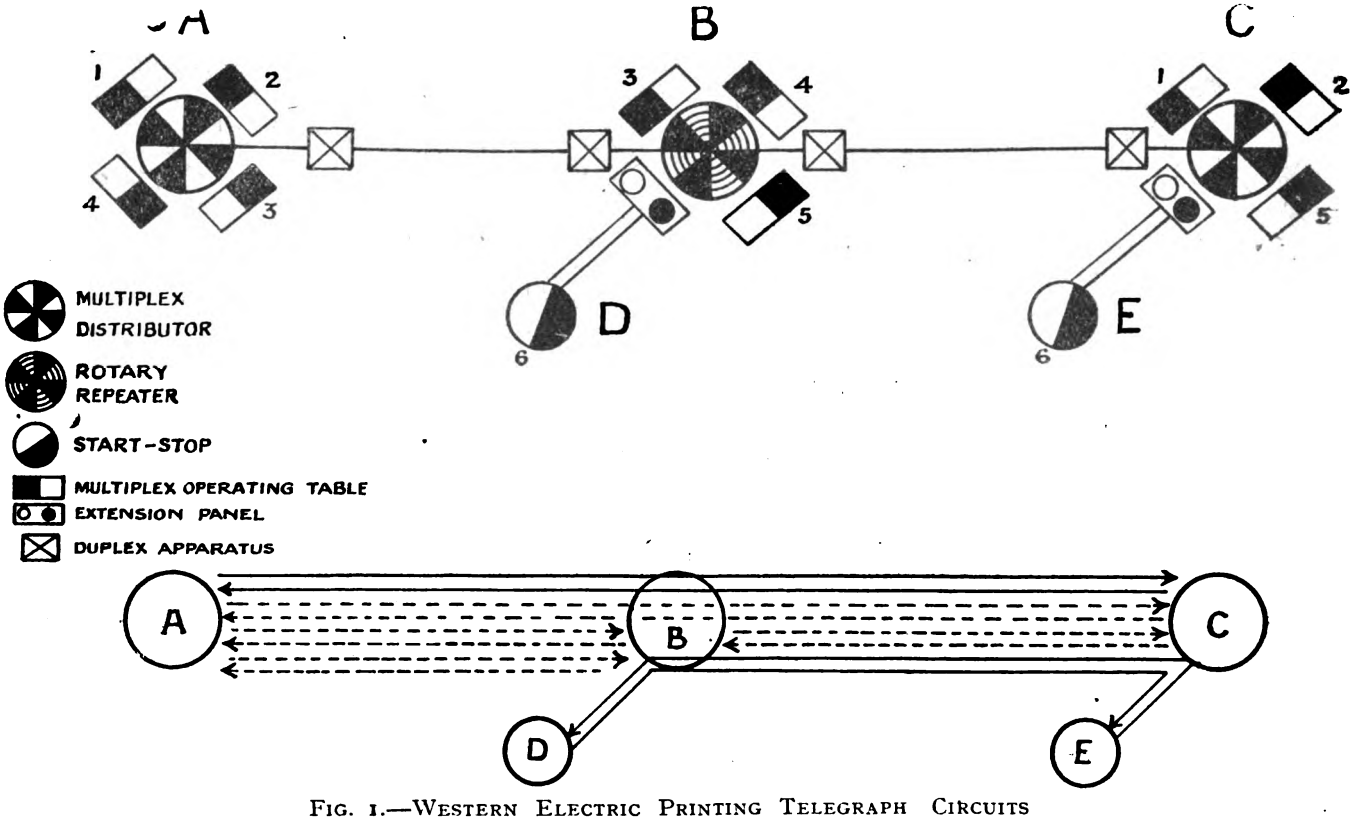


Fig. 1.—Western Electric Printing Telegraph Circuits

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and C with a rotary repeater at station B. One of the multiplex operating tables is replaced by an extension panel at stations B and C, and from these panels start-stop equipment is used on the branches to stations D and E. The lower diagram shows the traffic facilities then available. At one and the same time it is possible to deal with two messages in each direction between A and C; two messages in each direction between A and B; one message in each direction between B and C; and one message in each direction between D and E. Also, telephone conversations can be carried on simultaneously in the start-stop circuit between D and E. There is an almost indefinite number of possible combinations of traffic-carrying facilities between a number of towns served by multiplex or start-stop systems, but the simple example given is quite sufficient to demonstrate the value and flexibility of the equipment. In every case transmission is from a letter keyboard of the typewriter pattern (or from a tape perforated by use of such a keyboard) and the message is printed in ordinary type at the receiving station.

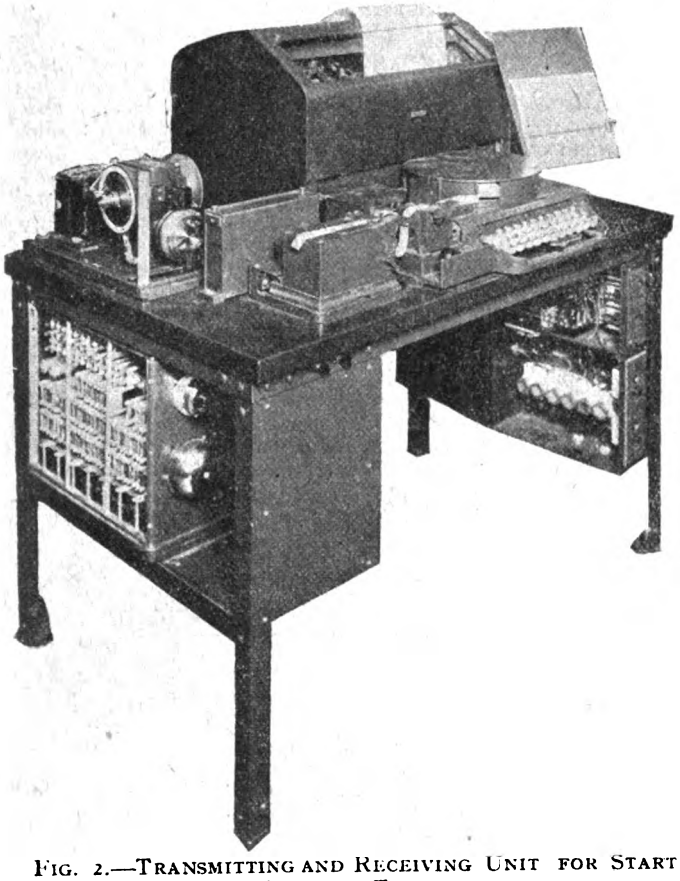


FIG. 2.—TRANSMITTING AND RECEIVING UNIT FOR START STOP PRINTING TELEGRAPH.

The apparatus on the operator's table (Fig. 2) in the start-stop system comprises the sending keyboard, with the receiving printer at the back of it, a perforator and transmitter, and the start-stop motor with its segment discs and brushes. The remaining components are on shelf-trays under the table, and every component is built as an independent unit which makes all the necessary connections automatically when slid into locating grooves on the table. Messages can be sent direct from the keyboard, which is an advantage in several respects: for instance, corrections can be sent (without first transmitting previously-punched tape), by changing over temporarily from tape to keyboard transmission. Normally it is advisable to transmit by tape because keyboard errors can then be corrected on the tape and never appear in the received message.

The sending brush picks up positive and negative impulses as controlled by the sending keyboard or tape transmitter, and the receiving brush picks up about one-quarter of the incoming signal. The same code is used as in the multiplex system with the addition of extra contacts, back and front, which start and stop the motor—hence the name of the system. The brushes rotate once for each letter, and this eliminates all difficulty associated with synchronising; it is quite sufficent if the motors at the two ends of a start-stop line are within plus or minus 5 per cent. of the same speed. A test contact is provided so that the operator can test his own apparatus by transmitting from the keyboard to his own printer.

It will be realised that the start-stop equipment has, in addition to its service capabilities in small post offices, a great field of utility in connection with private lines to bankers, stockbrokers and other commerical and industrial concerns. The equipment needs no attention demanding technical skill, but has been reduced practically to the simplicity of the typewriter and dictaphone. A typist rather than a telegraphist is needed to operate the machine, and a speed of 45 to 50 words per minute offers no difficulty whatever.

The W.E. Multiplex Printing Telegraph.—This equipment makes possible the simultaneous transmission of four messages in each direction. At the maximum service speed of 52 words per minute, this corresponds to a total traffic capacity of 416 words per minute. The vibrating fork which drives the impulse motor of the distributor is, however, provided with adjustable weights, so that any working speed between 25 and 52 words per minute per channel can be obtained, according to the condition of the line. The whole of the equipment—transmitter, distributor, repeater and printer—can be operated at 100 words per minute under laboratory conditions, hence the actual working speed adopted leaves a large margin which increases reliability and reduces maintenance costs.

As shown by Fig. 3, the operator's table comprises an equipment which is neat, simple and convenient.

Telephone type switches are used on the distributor table (Fig. 4) for testing, etc., and the provision of signal lamps in the test circuits greatly facilitates the work of the *dirigeur*. A synchronising switch is provided by means of which special impulses can be fed in to the impulse motor to bring it up to speed. Synchronism is indicated by a special lamp (this and the other signal lamps being of the telephone type); when the flickering of the synchronising lamp ceases the synchronising switch may be released and the impulse motor is in step. This operation takes only a few seconds and is a great improvement on bringing the motor up to speed by hand.

The printer signals can be switched on to a ring of lamps on the distributor table so that the *dirigeur* can observe the incoming signals without moving from his station. This and the various test switches greatly facilitate the location of faults. By turning a switch at the distributor table, synchronising impulses (1 negative and 2 to 20 positive) can be sent to line, and when the distant station does this the repeated "marking" impulse lights one of the signal lamps. If the speeds of the two stations are not equal consecutive lamps are lighted by the synchronising impulse in either the clockwise or anti-clockwise direction, according to the relative speed of the two distributors. When the correcting switch is thrown over, the synchronising impulses light only one lamp, which should be No. 1. If some other lamp is lighted instead, the receiving ring brushes are orientated until the No. 1 lamp glows. The setting of the sending ring brushes to allow for line lag is equally simple and the whole operation can be completed in a few seconds. The brushes on both the sending and receiving faces of the distributor can be turned a full 360 degrees in either direction.

Only two wires are needed between the multiplex equipment and an existing duplex circuit, so that, should the usual line become faulty, the distributor can be switched immediately on to a ready-balanced duplex set without necessitating the obtaining of a fresh balance.

Worn segments on the distributor can be replaced individually in a few moments and the elimination of the

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buffer from the synchronising equipment removes a part which needed periodical renewal in the old type equipment. The new distributor table occupies only half the floor space of the older type and the general arrangement and wiring represent the acme of reliability and simplicity.

At the rotary repeater station B (Fig. 1), the signals from A actuate two polar relays alternately, storing up each impulse for sufficient time to permit of its repetition from B to C by brush transmission. This ensures that even if the signals arriving at the repeater station are distorted, those sent out by the repeater are perfect. The repeater station is the pace-setting station. Line lag is allowed for at the terminal station, hence the repeater station is free from orientation adjustments. A feature of great practical importance is that the repeater relays do not spark at the contacts; the relay torque moves before there is any current to flow across the contacts, and it is held over until after the current flow has ceased.

The phasing between terminal stations with an intermediate repeater is effected by first proving the phasing between one terminal station and the repeater, and back again. A similar check is made between the other terminal station and the repeater, and the system can then be operated through from end to end.

The new printer is of the mechanical type, with type-bars and ribbon as in a typewriter. The paper carriage is fixed, the type-basket sliding along in front of the paper. This arrangement facilitates the insertion of paper and reduces the eye-strain on the operator. Up to 20 carbon copies can be made by adjusting the tension on the striker bar, and stencils can be cut if required. The machine can be set to operate at 100 words per minute, but for normal service the spring tensions are reduced to keep the maximum speed about 70 words per minute.

If desired, messages can be received on a perforator, the tape thus punched being used for re-transmission. If circumstances required it, the tape could be run through a dozen tape transmitters placed one behind the other, so that the message could be re-despatched on a dozen different lines with a total lag of only a minute or two between the first and last machines.

Where secrecy is essential, the W.E. enciphering system provides absolute security. Two tape-transmitters are inter-connected through a local rotary distributor to a re-perforator. The real message tape is fed though one transmitter, and through the other there is fed simultaneously a "scrambling" tape perforated with random signals or a dummy message. The two messages being received simultaneously by the re-perforator, produce a tape which is definitely unintelligible. This tape is used to send the line signals and to reproduce a similar tape at the far station. The received "scrambled" tape is fed through one local transmitter and a duplicate of the scrambling tape used at the sending station is fed through a second local transmitter. The printer is operated upon simultaneously by these two transmitters and prints the real message alone. Ciphering and deciphering on this system can be done at the rate of 50 words per minute and thus involves no apreciable delay.

The Western Electric Co. in America has established an interesting innovation by installing a quadruple duplex system between its head offices and works in New York and Chicago, a distance of about 1,000 miles. This telegraph service now replaces entirely all postal correspondence between the offices and works. The traffic is 50,000 to 60,000 words a day, and there is a great saving in time and total expense.

(To be continued.)

ELECTRICITY DEVELOPMENTS IN SCOTLAND.

For 1921 there are two large hydro-electric schemes to receive official sanction. One, the Lochaber scheme, is promoted by the British Aluminium Co., and deals with various lochs and roads; and the others is the Grampians, which also takes over Highland lochs for the water turbine and pelton wheel. Should the Government give the neces-

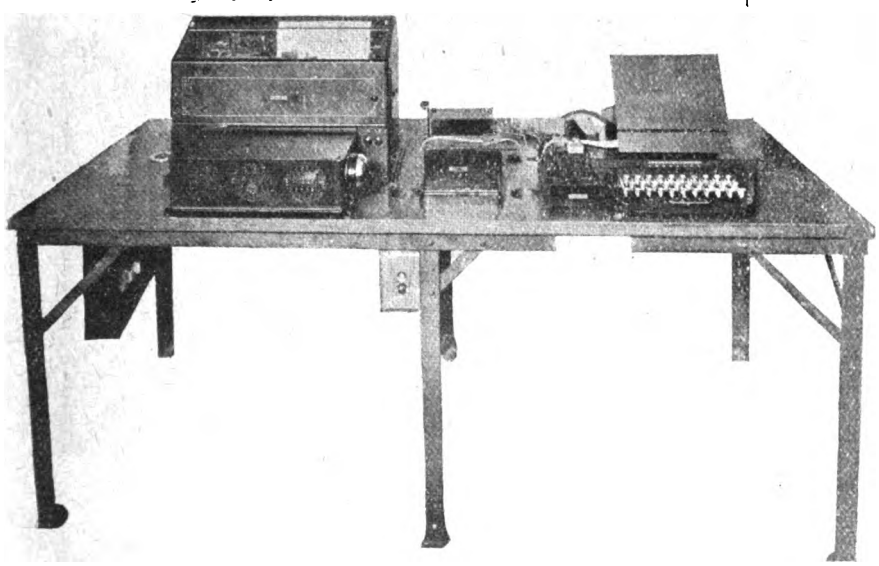


FIG. 3.—OPERATOR'S TABLE WITH SENDING KEYBOARD, PERFORATOR AND RECEIVING PRINTER (FOR WESTERN ELECTRIC MULTIPLEX PRINTING TELEGRAPH SYSTEM.)

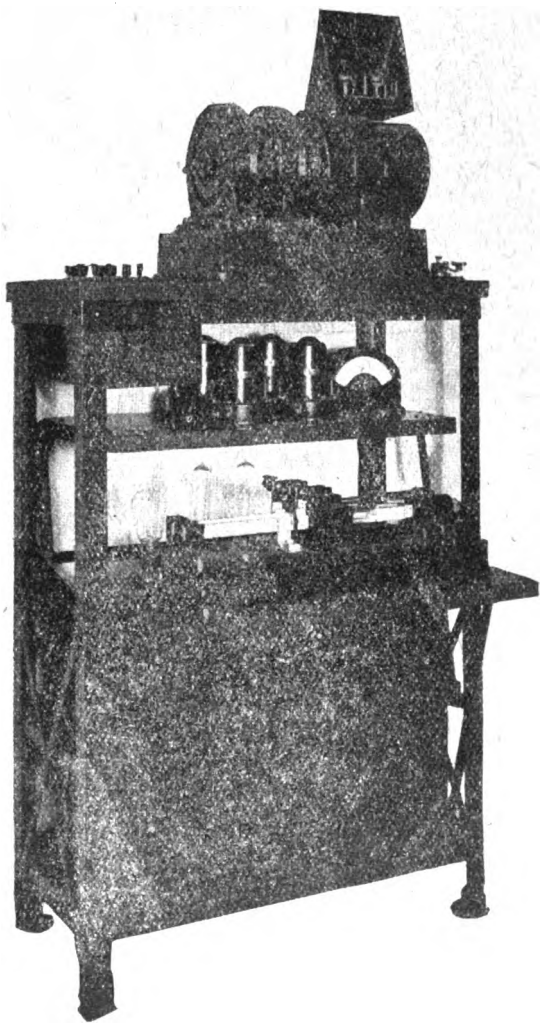


FIG. 4.—DISTRIBUTOR TABLE FOR WESTERN ELECTRIC MULTIPLEX PRINTING TELEGRAPH SYSTEM. SHOWING VIBRATING FORK, IMPULSE MOTOR, DISTRIBUTOR DISCS, TEST KEYS. ETC.

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sary authority, the aggregate expenditure of capital in these Highland districts will be seven million pounds, and the contracts carry over five years.

In Glasgow additional plant has to be installed at the large new Dalmarnock super-station, and for Edinburgh the new super-station at Portobello will represent a capital outlay of one and three-quarter millions sterling. Dundee is also enlarging its power station. The Clyde Valley Electrical Power Company have had a prosperous year. A 15,000 kilowatt turbo-generator is at present in course of erection in their Clyde Mill Power Station: and an interconnecting cable between their two generating stations, designed for operation at 33,000 volts is at present being laid. Large supplies are to be given by the Company to new power users.

Makers in Scotland of electric machinery and accessories have had in general a busy year. Orders for dynamos and motors have kept work full going, and the export trade has also been well maintained. Switchboards and motor control gear are in constant request. For collieries substantial ironclad equipment has been in demand, and for industrial works, open flat-back boards of a satisfactory reliable type are fitted up. And coal-cutters, conveyors, and other colliery plant are always on the list for early delivery. But all classes of electrical requisites have been booked by all descriptions of workshops and trades to aid in economy of time and labour. Domestic and hotel appliances are a safe selling line. Public lighting is extending and in certain towns such as Inverness, a small hydro-electric scheme is under contemplation for the economical supply of light and power to the town and vicinity.

Electrical manufacturing firms are devoting attention to the modern methods of standardisation in electrical plant. They have to counterbalance the extra costs of higher wages and reduced hours. By making standard machinery and appliances they cheapen cost of production, and to this end they are specialising in every way possible. Prospects for the forthcoming year are in all respects bright so far as concerns the demand for plant and all electrical equipment and fittings. This applies also to marine work. Electrical engineering firms have found the Clyde and Forth demand very constant for liners, and all classes of cargo steamers.

HIGH EFFICIENCY LIGHTING.

The lighting contractor and installation engineer is continually being called on, thanks to the awakening of the manufacturer and merchant to the vital need for correct lighting in industrial establishments as an aid to increased

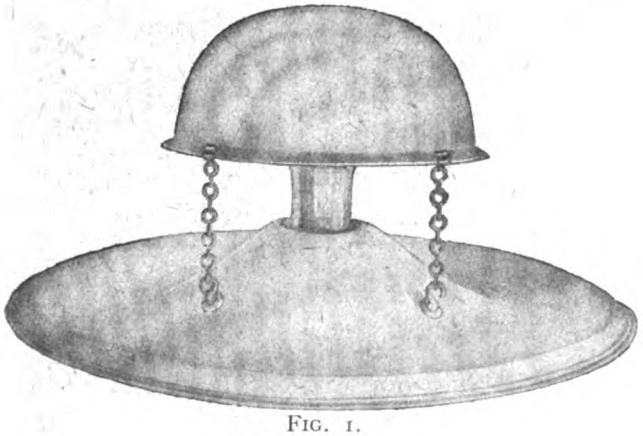


FIG. 1.

production and greater content among the operatives, to plan and erect suitable lighting equipment to meet most diverse conditions. The "High Efficiency Lighting" list just issued by the Sun Electrical Co., Ltd. (118-120, Charing Cross Road, W.C.2), will therefore prove a welcome addition to existing publications on the subject. Measuring 8 in. by 4 in., it is a convenient size for the pocket, and gives, besides brief notes of lighting, full particulars of the Company's complete range of Sunlite "P.E." reflectors of all types, extra extensive, extensive, intensive and angle for direct illumination and semi-indirect and indirect; "Diffusa," semi-indirect fittings, and Sunco lanterns, and a complete range of semi-indirect fittings utilising opal, holophane and alabaster bowls, and indirect fittings utilising matt white composition bowls. The Sunlite "P.E." reflector semi-indirect type (Reg. Design No. 658031) is shown in Fig. 1. The top reflector is of spun steel finished dead white vitreous enamel, while the opal bowl is suspended by chains on to studs; there is no metal rim to cast shadows. Another fitting, this time suitable for the illumination of important offices, is that illustrated in Fig. 2. It has an alabaster bowl and fancy link chain, and is one of a number available for use with gasfilled (half-watt type) lamps.

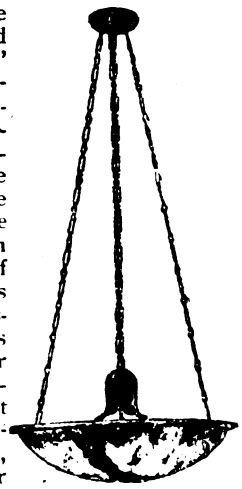


FIG. 2.

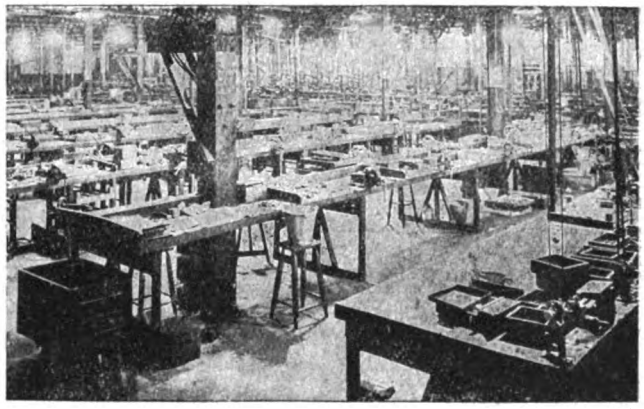


FIG. 3.

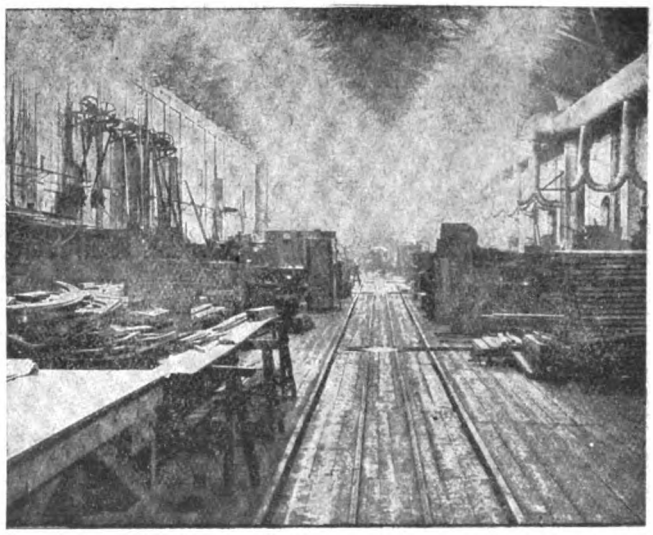
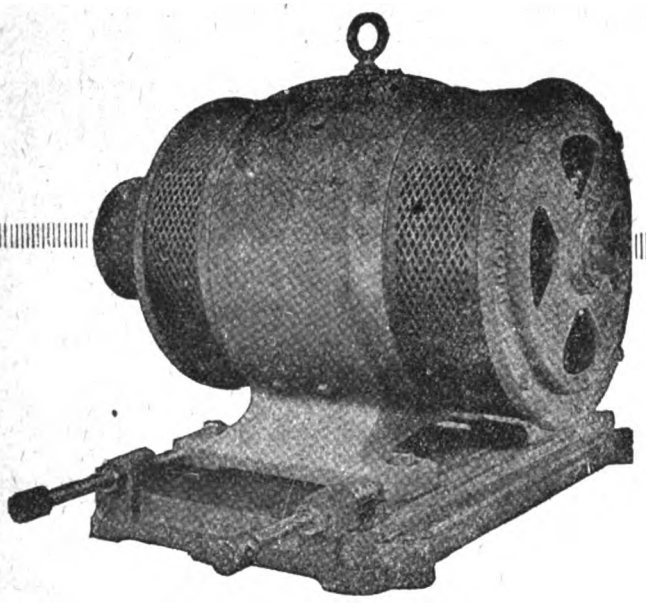


FIG. 4.

As examples of the illumination obtained with 300 watt half-watt type lamps in Sunlite "P.E." "extensive" reflectors, reference may be made to Figs. 3 and 4, the former being reproduced from an untouched night photograph of Messrs. Kynoch's Works, and the latter of Messrs. Metropolitan Carriage and Wagon Co.'s. Works.

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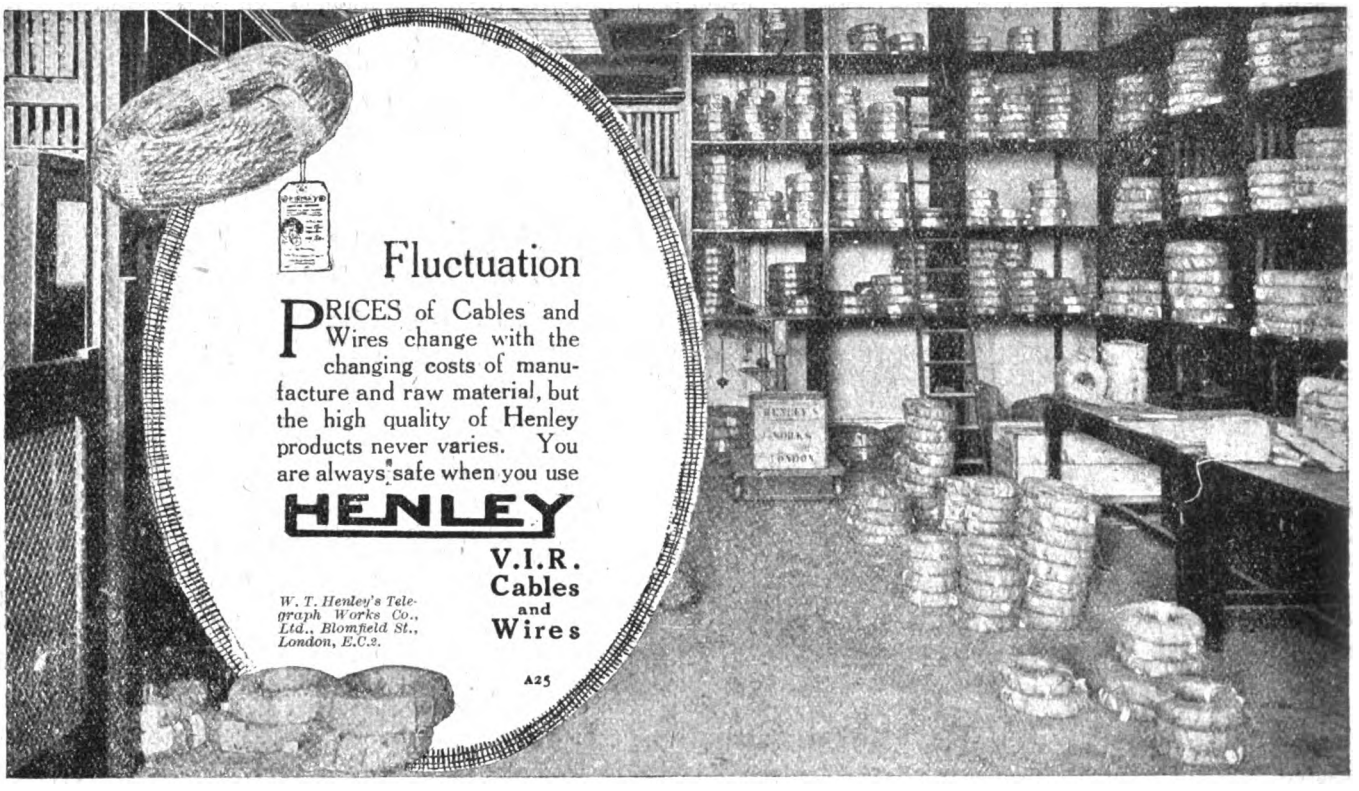
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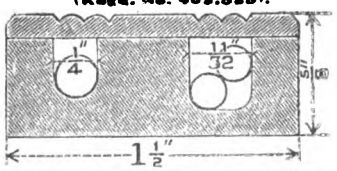
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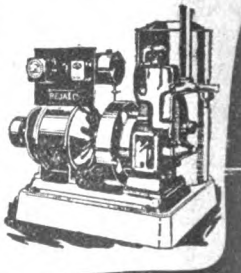
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Automatic Appliances.

In these servantless days, and with labour problems facing us on every side, there is a growing tendency to make everything as far as possible self-acting, or automatic as to its operation, thus lessening the amount of human attention necessary to the functioning of everyday appliances. In this connection a daily contemporary sounds a warning note anent the dangers attendant upon failure of such automatic principles at the psychological moment, and the risk of accident arising therefrom. As electrical apparatus is coming more into use everywhere it means that automatic appliances are becoming more general. To give them their due, electrical automatic appliances of modern construction generally do their work very well; they are in use for switching on pumping plant in connection with water supply at considerable distances from the source of power. They are also largely used in connection with hydraulic plant; as the supply of water in the reservoir above falls an electric motor is switched on, driving a pump which renews the supply in the reservoir, and is cut out immediately a certain level is reached.

They are in use in connection with the electric lifts now so common in hotels and public buildings; if anything goes wrong with the hoisting gear an automatic appliance comes into operation and prevents further mischief, stops the revolution of the drum, and so on. With a good many electric lift systems if any of the gates on the different landings are not closed the lift will not work; the electric circuit controlling the motor operating the lift is not completed until all the gates are closed. There is always a danger with automatic appliances that they may refuse to work just at the time they are wanted. With circuit breakers on tramway and other electrical services that are constantly in use, the automatic operation can be fairly well depended upon owing to the frequency with which the devices are called upon to function. With those that come into operation at infrequent intervals, however, it is very fortunate indeed if, when called upon, they do function promptly.

In most forms of automatic appliances a lever has to move, or a spring has to cause a contact to be made when the emergency apparatus operates. In too many cases the pivot or fulcrum of the lever may be dirty or corroded, and there may be so much friction present in consequence that the lever refuses to move. In the case of spring devices which are held back when normal, there is a strong tendency for the spring to lose its tension or acquire a permanent "set," which again militates against prompt action in an emergency. According to my contemporary, the most striking example of the unreliability of automatic electric appliances is the fuse. These are supposed to "blow" when a certain excess current passes through them, and thus break the circuit of which they form part, in sufficient time to prevent damage being done to the wires, cables, lamps, etc., they nominally protect. There is a certain amount of truth in this criticism of the common or garden fuse. Although brought to a very high standard of accuracy in fusing limits by the makers and designers, so much depends upon local circumstances that it is impossible to guarantee the prompt and reliable functioning of the best types under certain circumstances.

So much depends upon the position in which the fuse is placed, and the surrounding conditions. If located where there is a draught, especially in winter, a fuse may allow several times the current it should normally blow at to pass without performing its duty. If, on the other hand, it is located in an exceptionally warm spot, or in a damp situation, the metal of the fuse wire may oxidise, and the fuse blow at currents well below the prescribed minimum. All the wiring contractor can do to mitigate the evil is to choose the most approved design of cut-out for all his jobs and fix them in the positions which experience dictates are best suited to long life and reliability. In the matter of automatic apparatus which depends upon relays, electro-magnetic devices and the like, there is only one infallible principle of operation, the constant current system, in which the entire circuit is maintained normal by the passage of a steady current throughout the installation. Any failure of the current or accidental break or disconnection in the wires or coils constituting the protective circuit then automatically gives the signal that something is amiss. Such devices are self-testing, and can generally be thoroughly relied upon for infallible service in all emergencies.

A Self-Cleaning Fixture.

A Chicago firm has introduced a self-cleaning lighting fixture under the appropriate name of the Clean-Pull Unit. It comprises a reflector, a pull-switch, a cord and a cleaning device consisting of two wiping blades. Every time the cord is pulled to operate the switch it simultaneously brings the two wiping blades into action. Each blade makes a complete revolution, one against the reflecting surface of the reflector, and the other against the lamp bulb. In this way it is claimed that dirt is removed from both lamp and reflector. The fixture is designed to take 300 and 500 watt bulbs, and is sent out completely wired and assembled so that any maintenance man may install it on existing wiring schemes. In view of the important part played by accumulated dust and dirt in reducing the illuminating efficiency of electric light fittings the new device, if it does all that is claimed for it, should soon pay for itself.

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The Electric Vehicle.

This year is going to see considerable development in the use of the electric vehicle for utilitarian purposes. Among other opinions, Mr. Richard Twelvetrees expresses the view that in sizes from 15 cwt. to 3½ tons they have a range of action varying from about 50 miles for the smaller to 35 miles for the largest vehicle. Although incapable of competing with steam or petrol for speed the electric truck is clean, easy to control, convenient in traffic, and has very low upkeep charges. Its field of usefulness will no doubt grow as schemes now under consideration for providing battery charging depôts, come into practical operation. Owing to the simplicity of the driving mechanism the frame of the electric lends itself peculiarly well to various forms of body work.

Apropos of charging facilities, the development of depôts for this purpose must go hand in hand with the multiplication of vehicles, and in this connection my contemporary, the *Electric Vehicle*, points out that the great need of the time is the institution of garages and charging stations, which will reduce the electric vehicle proposition to its simplest terms, so far as the user of the vehicle is concerned. Only in a few cities has any material progress been made in this direction. At Ipswich the extensions now under way at the central station garage will increase the accommodation from the eighteen to the forty vehicle standard. In Newcastle a company—the Northern Electric Vehicle Services, Ltd.—has been formed to promote the use of battery vehicles, tractors, trucks, locomotives, launches and cranes on the north-east coast area supplied by the Newcastle-upon-Tyne Electric Supply Company, Ltd., and its affiliated companies covering the counties of Northumberland, Durham and the Cleveland district of Yorkshire.

ELEKTRON.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and addres must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 109.

I have a motor starter with the resistance burnt out. It is 40 horse-power, 440 volts. How can I calculate the size and quantity of wire required to rewind this resistance to start against full load?—"ASTATIC."

QUESTION NO. 110.

How are water wheel generators got into exact step? With a steam turbine, a small hand or motor operated wheel will give a small amount of regulation of speed. Is a similar method adopted with water wheel generators?—"PHASE."

(Replies to Questions Nos. 109 and 110 must be received not later than January 29, 1921.)

Answers to Questions.

QUESTION NO. 108.

We have heard lately of a plan to use the power of sea-tides and sea-waves for generating electricity. Can you or any of your readers tell me if this is practicable or not? If practicable, can you explain how it can be performed?—"ESSESS."

REPLIES TO QUESTION NO. 108.

The first prize (10s.) has been awarded to "Hydro" for the following reply:—

From the nature of this question it is quite evident that "Essess" must have sent it to ELECTRICITY before the advent of the famous Severn Barrage scheme. Although I do not wish to criticise the possibilities of this scheme, I might say that there is food for thought if "Essess" cares to go into the details of it.

What I suppose "Essess" requires is some practical information concerning the harnessing of water, the term to contain information other than that of tides and sea waves. If this is so then I can give him some information which may be of assistance to him, or satisfy his curiosity.

Referring to the harnessing of streams, it should be remembered that the flow of water is not constant, but varies because of the variable factors upon which it is dependent. These may be set out as follows:—

1. The rainfall varies from week to week
2. The rainfall is not the same each year.
3. The evaporation due to sun and weather is not constant.
4. The "run off" is variable.

The only factor which remains constant is the area of the watershed.

In the majority of cases the amount of water that can be harnessed, or the amount of power developed, depends upon the facilities for "damming" the surplus power to create a reserve. The construction of a dam calls for the assistance of a civil engineer, and he must be a person who thoroughly understands his business as far as dams and irrigation schemes are concerned. A badly constructed dam will very quickly lead to the whole plant being defective, thus wasting a considerable amount of money.

Water power depends upon two factors:—

1. The head of water.
2. The flow of water.

The former is the height of the fall, or the difference in elevation between two points on the stream, and the latter is the volume of water passing in a specified time.

The head is found by direct measurement after the ground has been carefully surveyed and the position of the power house determined. The flow must be accurately determined by one of two methods generally used. As a precaution both methods should be tried and one checked against the other. The simplest method is to utilise a weir, that is, if the stream is not large. It may be said that a weir is a large crested dam placed so that the water will flow over it without restriction. It is known that for any given depth of water over the weir a definite quantity will flow per minute.

To construct the weir a board is placed across the stream at some point which will allow a pond to form above. The board should have a notch cut in it with both edges and the bottom sharply bevelled towards the intake. The bottom of the notch is termed the crest of the weir and it should be perfectly level. The object of the sides is to divert the water through a definite and known measured path.

In the pond at the back of the weir, at a distance not less than the length of the notch, a stake is driven with its top exactly level with the crest. Now, by means of a rule or graduated stake the depth of water over the top of

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the stake is measured making allowance for capillary attraction of the water against the sides of the rule. For extreme accuracy this depth may be measured to a thousandth of a foot by means of a "hook gauge" which is familiar to all engineers.

For measuring larger flows, the use of a weir would be either very expensive or impracticable. In such a case, however, the cross section of the stream is found by measuring the actual depth of water at equal intervals between the banks. Then, to get the flow, it is only necessary to ascertain the average velocity of the water. This may be done quite easily with the aid of a current meter.

That there is room for the development of water power in this country, and others, there is not the slightest doubt. It must not be thought that the most important factor is a high head of water. This is not so since quantity will, under a low head, make up for a very high head with a small amount of water.

One of the most successful low fall hydro-electric development installations is the one at Chester. Here the average head of water is only 7 feet, and during certain periods of the year this falls as low as 5 feet. There are three units in this installation, two designed for a quantity of water as large as 30,000 cubic feet per minute, and a smaller unit which demands 22,000 cubic feet per minute. The h.p. of the units are 415 and 305 h.p. respectively.—"HYDRO."

The second prize (5s.) has been awarded to "M. M." for the following reply:—

Many fantastical ideas for utilising the energy of tidal and wave motion have been brought forward, but the majority of the suggestions are impracticable. There is, however, much to be said in favour of some of the schemes for taking advantage of tidal motion.

The notion of having floating wheels can scarcely be considered a commercial proposition; neither is the arrangement of submerged "screws" to be rotated by the flowing water. In both these ideas the supply of energy is intermittent. This could be met by electrical storage, but this means complication and expense.

The most feasible proposition appears to be, to dam the water at high tide and to utilise its potential energy by means of turbines. In considering such a scheme it must be remembered that the total energy of the water, in horse-power, is equal to the weight of water in pounds multiplied by the fall in feet per minute and divided by 33,000. Owing to the inefficiencies of turbines and generators, only about 50 per cent. of this would be available as electrical energy. It is, therefore, evident that a large quantity of water must be stored, and this meant an extensive plant. As a result, such a plant will almost certainly be some distance from the consumers, which again means long cable lines. A further point is that the smallest tides must be taken as the basis for calculation and provision made for reserves. If pumping machinery is employed as a reserve, it might be better to have steam-driven generators. But this brings us back to the usual generating station.

Generally, there are no doubt conditions and circumstances under which such a method of obtaining mechanical energy for driving electrical generators would be a commercial proposition. There are no doubts as to the engineering possibility. Each case must be decided on its merits. There are many factors, local as well as general, to be taken into consideration.—"M. M."

Service Notes.—It is stated the emoluments paid to electrical officers whilst on sea service are to receive further consideration. One of the branches of the technical services which have expanded since the close of the war is the wireless telegraphy section of the Signal School at Portsmouth. Some civilian scientists and about 20 officers are attached to the experimental section of the school. A wireless telegraphy course will open at the Maresfield Training Centre on the 7th February next for officers of the Royal Corps of Signals. Recruiting for the wireless and electrical departments of the army is going on fairly in London and some of the provincial recruiting areas.

ELECTRICAL ENGINEERING, GRADE II., C.G. WORK.

Solutions to Questions set at the 1920 Examination the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page* 784, vol. xxxiv.)

Q. 8.—Explain what is meant by the circle diagram for an induction motor. What tests must be made in order to enable the circle diagram for a motor to be drawn? Show how (*a*) torque, (*b*) maximum power factor, (*c*) slip for such a motor may be found from the diagram.

A. 8.—The tests necessary to obtain the data required for drawing the circle diagram of an induction motor consist of (*a*) the no-load test, in which the line current and total power taken by the motor are measured when the machine is running light at its normal voltage and frequency, and (*b*) the short-circuit test, in which the rotor is held stationary with the starting resistance all cut out, and the line current and total power are measured with only about a quarter or a fifth of the rated voltage across the stator winding. The current that would have been obtained on the short-circuit test had the full voltage been applied is then given by:—

$$\text{Current on S.C. test} \times \frac{\text{Rated voltage of motor}}{\text{Voltage on S.C. test.}}$$

$$\text{Also, P.F. on S.C.} = \frac{\text{Power taken on S.C. test}}{1.73 \times \text{S.C. current} \times \text{voltage on S.C.}}$$

$$\text{And P.F. on N.L.} = \frac{\text{Power taken on N.L. test}}{1.73 \times \text{N.L. current} \times \text{rated voltage.}}$$

The circle diagram shown in Fig. 7 can now be constructed. *OV* is the voltage vector; *OA* represents

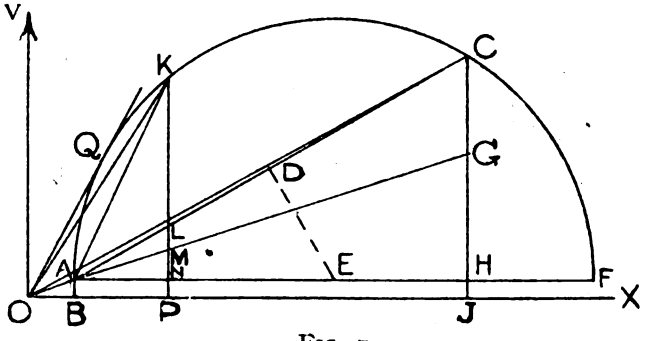


FIG. 7

to scale the no-load current lagging behind *OV* by $V\hat{O}A$, where cos *VOA* is the P.F. obtained from the no-load test. *OC* represents to the same scale the calculated short-circuit current and lags behind *OV* by $V\hat{O}C$, cos *VOC* being the P.F. derived from the S.C. test. Line *AC* is then drawn and bisected at *D*. *OX* is drawn perpendicular to *OV*, and *AF* parallel to *OX*, and line *DE* is drawn at right angles to *AC*, cutting *AF* at *E*. With this point as centre, and with radius *EA*, semi-circle *AQCF* is described. If any point *K* be taken on the arc *AQC* of this semi-circle, and if *OK* be joined and *KP* drawn perpendicular to *OX*, then when the motor is taking the current represented to scale by *OK* we have that—

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Cos VOK is the corresponding power-factor,
KP represents corresponding power component of current,
OP represents corresponding wattless component of current,
AK represents corresponding rotor current reduced to the stator winding; the actual rotor current being—

$$AK \times \frac{\text{Stator turns per phase in series}}{\text{Rotor turns per phase in series}} \times \frac{\text{Stator phases.}}{\text{Rotor phases}}$$

Also, OB represents the magnetising current per phase; while AB and CJ represent the power components of the current on no-load and short-circuit respectively.

Next, let CH be divided at G, so that

$$\frac{CG}{GH} = \frac{\text{rotor } I^2R \text{ loss}}{\text{stator } I^2R \text{ loss}}$$

Then if AG be joined, cutting KP at M, we have

$$KA^2 = KN^2 + AN^2 = AN.NF + AN^2.$$
$$= AN\ (AF - AN) + AN^2 = AN.AF.$$
$$= AH \times \frac{MN}{GH} \times AF.$$

$\therefore$ $MN \propto KA^2$, since AH, GH, and AF remain constant for a given motor.

Again, $$\frac{MN}{GH} = \frac{LM}{CG}$$

$$\therefore\ KA^2 = AH \times \frac{LM}{CG} \times AF.$$

so that $LM \propto KA^2$,

i.e., the intercept LM between AC and AG varies as the square of the rotor current AK, and is consequently proportional to the rotor I^2R loss. Also, the intercept MN between AG and AH varies as the square of AK which is approximately proportional to the stator current OK; so that this intercept can be assumed to be proportional to the stator I^2R loss. Hence it follows that with a stator current OK,

MN represents the component of the current supplying stator I^2R loss,
LM represents the component of the current supplying rotor I^2R loss,
KM represents the component of the current supplying power to rotor,
KL represents the component of the current supplying output of rotor.

Hence $$\frac{LM}{KM} = \frac{\text{Rotor } I^2R \text{ loss}}{\text{Power to rotor}} = \text{slip},$$

and $$\frac{KL}{KP} = \frac{\text{Output of motor}}{\text{Input of motor}} = \text{efficiency}.$$

It will now be obvious that the output corresponding to an input line current of OK

$= KL$ (to scale) $\times$ line volts $\times$ 1.73 watts

$$= \frac{KL \times \text{line volts} \times 1.73}{746} \text{ h.p.}$$

The power-factor can be obtained either by measuring $V\hat{O}K$ and referring to a cosine table, or by determining the ratio $\frac{KP}{OK}$ from the diagram.

The torque exerted by an induction motor is proportional to the rotor input, and is consequently proportional to KM. If T be the torque exerted in pound-feet,

$$\text{output of motor} = \frac{2\pi T \times \text{rotor speed (r.p.m.)}}{33{,}000} \text{ h.p.}$$

$$= \frac{2\pi T \times \text{synchronous speed}}{33{,}000} \times \frac{KL}{KM} \text{ h.p.}$$

since $$\frac{\text{rotor speed}}{\text{syn. speed}} = 1 - \text{slip} = 1 - \frac{LM}{KM} = \frac{KL}{KM}$$

Hence, $$\frac{KL \times \text{line volts} \times 1.73}{746} = \frac{2\pi T \times \text{syn. speed}}{33{,}000} \times \frac{KL}{KM}$$

so that $$T = \frac{KM \times \text{line volts} \times 1.73 \times 33{,}000}{2\pi \times 746 \times \text{syn. speed}} \text{ pound-feet,}$$

the synchronous speed being, of course, given by

$$\frac{60 \times \text{frequency}}{\text{pairs of poles.}}$$

The maximum power-factor is obtained by drawing OQ a tangent to the semi-circle, and measuring $V\hat{O}Q$; then cos VOQ gives the maximum P.F. of the motor.

(To be continued.)

ARMATURE WINDING (TESTING).

By C. Sylvester, A.M.I.E.E., A.M.I.Mech.E.

When one considers the extensive use of direct currents for power purposes it is really surprising that the subject of armature winding is not better understood than it is. The isolated power plant electrician has my sympathy because he is expected to perform the proverbial miracles with his motors. If a breakdown occurs he is expected to "get the machinery going again" irrespective of the lack of instruments for testing and, in many cases, the electricians lack of ability to carry out the tests even if the instruments were available.

I do not wish to convey the impression that the average electrician is not competent. This is very far from my mind at the present moment. What I do wish to say is that the average electrician does not know, and he really should not be expected to know, *everything* about armature winding as far as his plant is concerned.

As I have said before, the electrician in charge of the isolated power plant has my sympathy. He has to take the full responsibility of his plant. If a motor breaks down he is expected to be able to test it and locate the fault. He is expected to be able to carry out the necessary repairs, even if they are to the extent of rewinding an armature. Armature winding is an art, and it takes years of experience, both practical and technical, before the subject is thoroughly understood. It is no wonder, therefore, if the electrician in charge of the isolated plant has to scratch his head when anything is wrong with the armatures of his motors. It is for the benefit of such electricians that these few notes are written.

Direct current motor armatures are wound on a principle know as "lap" or "wave" winding; sometimes a mixture of the two windings is used. To the average electrician, all armatures look alike, no matter how they are wound, and the only method of determining the correct winding is by testing, a proceeding which should only be carried out if the circuits through the armature are in the mind's eye. Of course, the cause of some breakdowns are quite clear at times. It does not require an expert, for instance, if a coil burns out to know that a new coil will be required. It will, however, require more than the average electrician's knowledge to be able to say if more than one coil is defective.

In order to facilitate the testing of an armature the two following points should be remembered:—

1. In a lap wound armature there are as many paths through the windings as there are poles in the yoke of the machine. That is, a four-pole machine will have an armature through which there are four paths when the

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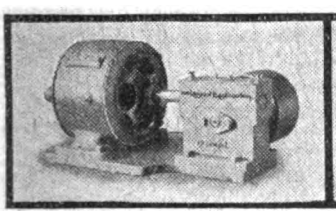
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armature is fitted in its position, a six-pole machine will have six paths, and so on.

2. In a wave-wound armature there are only two paths through it, no matter what the number of poles in the yoke of the machine may be.

Referring to the first item, its meaning should not be misunderstood. It should be remembered that the coils are laid in slots in the armature core according to the pitch of the pole pieces in the yoke of the machine, but the respective connections of these coil ends to their commutator segments are the same irrespective of the number of poles in the yoke of the machine. Thus in a simplex winding one end of No. 1 coil will be connected to No. 1 segment, the other end to No. 2 segment, one end of No. 2 coil to No. 2 segment and the other end to No. 3 segment, and so on.

From this it will be seen that the whole of the coils are in series and that when the whole of the brushes are down on the commutator the circuits through the armature will be in proportion to the number of sets of brushes. Here, providing the brushes are equally spaced, the current through each path will be equal. If they are not equally spaced, then each path will carry an uneven current and the result will be considerable sparking at the brushes.

It is, therefore, quite clear that if the motor is to run efficiently the whole of the brushes must be correctly spaced, they should be making excellent contact with the commutator, and care should be taken to see that any uneven wear will not allow them to lead or lag behind each other.

When testing an armature of this description it should be tested in its position in the yoke of the machine. Then the brushes may be lifted as desired and various tests taken which will give a true indication of the type of winding and the faults in the armature, if any. This will be probably more clear if Fig. 1 is studied a little. Here an

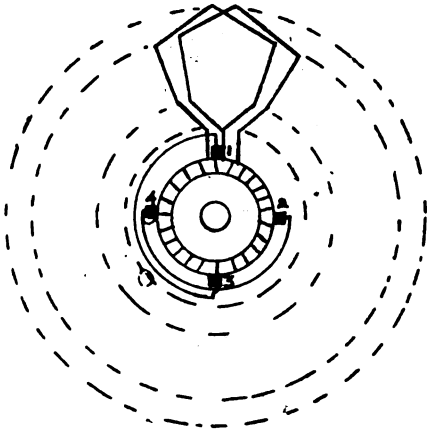


FIG. 1.

armature is shown with four brushes resting on the commutator marked 1, 2, 3 and 4. The four paths through the armature are 1 to 2, 1 to 4, 3 to 2, 3 to 4. If balancing the armature with a Wheatstone bridge between any adjacent pair of brushes the results should be the same. That is, the reading obtained will be relative to the joint resistance of the four paths in parallel. As it will be easy to ascertain the resistance of any one coil by balancing, the joint resistance of the four paths should be equal to the resistance of the number of coils between any adjacent pair of brushes divided by four.

If brushes 3 and 4 are insulated from the commutator with pressspahn and a balance taken between brushes 1 and 2, then three parts of the whole of the coils are in series, and these are in parallel with the remaining quarter of the coils. The result of a balance in this case should be equal to the joint resistance of one quarter and three quarters of the coils in parallel. From these remarks it will be seen that if the whole of the circuits are in the mind's eye, it will not be difficult to know whether the actual results obtained are in accordance with the anticipated results. From these two the type of winding may be determined and if it is healthy or not

In a wave-wound armature things are much different, since, no matter how many brushes may be on the commutator there are only two paths through the armature.

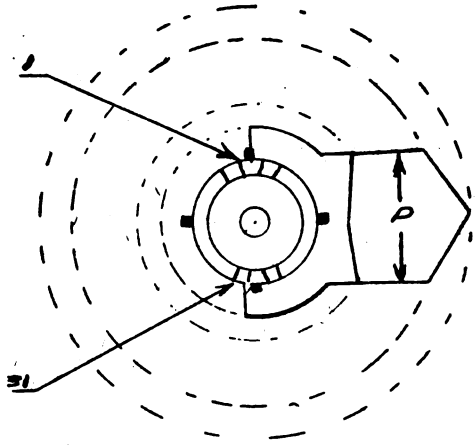


FIG. 2.

This may be more clear if Fig. 2 is considered for a moment. Here an armature is shown with four brushes on the commutator. Only one coil is shown in position, this being suitable for four-pole wave finding. If we presume that there are 61 segments in the commutator, then a suitable commutator connection will be: One end of No. 1 coil to segment No. 1, the other end to segment No. 31, No. 2 coil will be connected between segments No. 31 and 61, No. 3 coil between segments No. 61 and 30, No. 4 coil between segments No. 30 and 60, and so on.

Here it will be seen that to obtain the resistance of one coil it will be necessary to balance between segments 1 and 31, and that if any two points, at right angles on the commutator, are tested the reading obtained should be equal to the joint resistance of two paths in parallel, each path containing half the total number of armature coils in series.

The difference in the two windings call for the necessity of adopting "sure" methods when carrying out a drop test. In a lap-wound armature the testing leads, carrying the testing current, should be lightly soldered to the commutator segments which are diametrically opposite to each other. I advocate soldering because this method ensures a good electrical contact. In some winding shops it is really pitiable to see pieces of string tied round the commutator and the testing leads merely poked under them. Where such methods are adopted the results of the tests are not a reliable guide to the condition of the armature, and there should be no surprise if an armature gives out almost immediately it is placed in service.

I would now like to say a few words about armature winding diagrams. Although in my book, "Armature Winding," I advocate that time is not wasted if the armature winder endeavours to follow a winding by drawing a rough diagram of the progress through the coils, I do not think that any winder should attempt to draw a complete winding diagram. Complete winding diagrams are deceptive from the fact that they are beset with pitfalls. Of these the possibility, and the undoubted probability, of the pencil straying from one line and taking up its position on another line makes the method unreliable.

To replace complete winding diagrams I advocate the use of figures, merely depending upon a diagram for the position of the first two coils. To illustrate this we will again refer to Fig 2. There is sufficient detail in this diagram for a complete armature winding. For instance, if we presume there are 43 slots in the armature core, and that the machine is one of four poles, then P will be 1 to 11. The remaining coils will follow the same pitch,

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that is, 2 to 12, 3 to 13, and so on. In a six-pole machine the slot pitch will be 1 to 7, 2 to 8, and so on.

The same may be said of the connections of the coils to the commutator segments. It is only necessary to show the actual connections of the first two coils, this being a guide to short or long pitch connections. A glance at a complete figure "winding diagram" will immediately show any error made in the calculations, and they can be rectified quite easily instead of having to wade through and over lines where an error has been made and where, in checking, the same error may be made again.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

SECOND COURSE IN MATHEMATICS FOR TECHNICAL STUDENTS. By P. J. Haler and A. H. Stuart. 363 pp. 134 figs. (University Tutorial Press. 6s. net.)—The importance of a sound knowledge of mathematics to all technical students is now generally recognised, and this book, which continues the scheme of the authors' First Course in Mathematics, is one of quite exceptional value. The two books together provide a three years' course on the subject, and it is suggested that from the beginning of the second year the student should read Chapters I. to VIII. concurrently with Chapters IX. to XII. in the present book. The first eight chapters deal with the laws of indices and logarithms, algebraic operations, functions, areas and volumes, graphs, and the differential and integral calculus. The second half of the book, to be read simultaneously with the above, deals with geometry, measurements of angles, three dimension geometry, and scalar and vector quantities. A novel and most useful feature of the chapter on three dimension work is that all the figures are drawn so as to be suitable for viewing through a common stereoscope. When thus inspected the figures appear actually to possess three dimensions, and we should certainly recommend every reader who has any difficulty in forming a conception of three dimension geometry to purchase a cheap stereoscope for use with this book.

The exercises, which form so vital a part of any book on mathematics, are here taken from a very wide range of technical work, and answers are given to all of them. Every reader should be able to pick out an ample number of problems of varied difficulty, bearing more or less directly upon his vocation. In addition there are a number of purely mathematical problems, some of them of considerable difficulty, so that the needs of the student who is interested in pure mathematics and wishes for problems which will try his skill to the utmost, are also met. It should be clearly understood, however, that the primary aim of the book is to meet the requirements of the average technical student, and this is done very effectively. All the mathematical problems likely to be encountered in ordinary machine tool work are included, and there are also a number of problems dealing with modern methods of measurement, with limit gauges and tolerances, Johansson blocks, and methods of measuring taper by standard rollers. The general principle underlying the slide rule is treated in detail, but the actual description of this instrument and of the planimeter is purposely brief, the authors wisely emphasising the necessity of actually handling the instruments themselves. We have no hesitation in recommending this and the companion volume as being thoroughly suitable for technical students in junior day technical schools, trade schools and evening technical schools.

ELECTRIC WELDING. By H. S. Marquand. 204 pp. 90 Figs. (Benn Bros. 12s. 6d. net.)—During the past ten years or so enormous progress has been made in the industrial applications of electric welding, and, indeed, it is only those who are immediately associated with electric welding who realise the diversity of applications and the excellence of results which can now be obtained by this process. We therefore greet with pleasure the appearance of this book which deals comprehensively with the whole subject and provides a clear and practical exposition of the technique of electric welding which should be most useful to electric welding operators, manufacturers, students and others. Electric welding can be applied in almost every branch of metallic construction and repair. During the early days of the art "rule of thumb" methods were extensively employed, but during the past few years there has been conducted a great deal of careful experimental and research work so that it is now possible to obtain with certainty thoroughly reliable results. In this manual there is presented a reliable collection of data digested and presented in such form as to be capable of direct application to practical work.

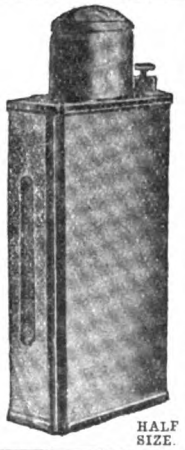
After preliminary chapters devoted to a discussion of methods of making permanent metallic joints and of the properties of metals considered from the welding point of view, the author gives a general survey of electric welding processes and then describes in detail the various methods of resistance welding and arc welding. The methods described include the latest forms of spot and seam welding and electro-percussive welding, and also the various arc welding processes using metallic electrodes. In this connection it is interesting to note that the writer has concluded from a great amount of research work that the metal electrode arc welding system is the best for commercial welding and is capable of considerable improvement and extension.

The selection of electrodes and current values for arc welding are considered in detail, and there is an important chapter on the chemical and physical properties of metals and their influence on welding. The chapter on the applications of electric welding is naturally one of the longest and most interesting in the book. The examples given are very well selected and afford indisputable evidence as to the extraordinary versatility and practical value of electric welding in all branches of industry, both for manufacturer and repair. The possibilities of automatic and semi-automatic welding machines for repetition work deserve to be more generally known. The concluding chapters are brief but important and deal with the testing and strength of welds, with the characteristics of metallic arc fusion and factors affecting fusion, and with the economics of electric arc welding. There is a useful list of technical papers on welding, and altogether this volume is quite a classic work.

Cassell's Engineers' Handbook.—Part 19 is the conclusion of this very useful work of reference and contins the finish of the chapter on Sundry Notes and Tables, as well as a copious index, title page, etc., and we most strongly recommend that all readers who have taken in the parts as published should have them bound up without delay. It will then form a splendid work of reference for future use.

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Various Items.

Plant for Sale.—An advertiser has for sale a complete electric lighting plant and a pumping plant. For particulars see small adverts. page.

Storage Battery Wanted.—An advertiser wants to purchase a second hand 300 amp. hour storage battery. For particulars, see small advertisement.

Toronto.—An inquiry has been received from a quarrying undertaking for certain electrical plant. U.K. firms interested may obtain the name of this inquirer on application to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Brussels.—Tenders are invited for the construction and installation of a turbo-alternator group for the Commune of Ixelles. The plant required includes a turbine, a 5,000 kw. 5,000 volt 3-phase alternator, an exciter and a condenser. The Specification (in French) may be consulted at Room 48 of the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Wages Cut Down.—The U.S. Federal Reserve Board's monthly statement, reviewing business and financial conditions records a further decline in prices, bringing the Board's index number to 198 per cent. of the 1913 level, the month's decline being 8½ per cent. The increase of unemployment resulting from reductions of business activity, varying from 40 to 75 per cent. of normal, has affected labour unfavourably. Wage reductions, running as high as 20 to 25 per cent., have accompanied the shrinkage of demand, and there has been a falling off in the export trade.

Presentation.—At Preston last week, a presentation of a silver tea and coffee service, hot water bottle and stand, and silver tray was made to Mr. James Connor, consulting mechanical engineer to Messrs. Dick, Kerr & Co., Ltd., in recognition of his services for 19 years as works manager. Mr. J. Taylor presided, supported by Mr. W. Ruthertord, managing director, London; Mr. R. Livingstone, manager of Preston Works; Mr. H. B. Player, commercial superintendent; Mr. A. D. Salisbury, general foreman, and others. Mr. Connor is transferring his services to the English Electric Co., Ltd.

The Electrical Development Association still carries on the good work of electrical publicity, and does it well. Among a recent batch of telling publications are a circular letter offering assistance in connection with local Electrical Exhibitions, Notes of Electricity Supply Regulations, Post and Correspondence cards with appropriate inscriptions, folders on Shop Lighting and Window Displays, Electric Appliances as Presents, Radiant Heat, Silent Aids to Comfort, Bookmarkers, adhesive labels, etc. Electrical contractors and supply authorities should make full use of the facilities afforded by the E.D.A. for advertising electrical service.

Rhodesia.—The Municipality of Salisbury, Rhodesia, call for tenders for the installation of electric lighting plant, including two or three 300 kw. 3-phase, 50-cycle, 2,000 volt generators direct-coupled to multicylinder vertical gas engines with producer plant to burn Wankie bituminous coal, two 3-phase A.C. to D.C. converters, main switchgear, converter switchgear, gas mains and underground cable. Owing to the short time available for tendering, only those firms who are represented in South Africa will be in a position to submit tenders, but the specification may be consulted on application to Room 48, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Adelaide.—Three separate tenders are invited by the Deputy Postmaster-General, Adelaide, for the supply of Telephone parts (Schedules 558 and 559) and Telegraph and Telephone material (Schedule 560). Commonwealth sealed patterns of the material required may be seen on application at the offices of the High Commissioner for the Commonwealth of Australia, Australia House, Strand, London, W.C. Tenders in each case close at noon on Wednesday, 2nd March, 1921. Specification forms may be seen on application to Room 59, Department of Overseas Trade, 35, Old Queen Street, S.W.1, or to the Inquiry Room of the City office of the Department, 73, Basinghall Street, E.C.2.

Accrington will have to consider extensions to its electricity plant & the works, involving an expenditure of £150,000. This is the outcome of the permission of the Ministry to fill their existing station and follows on the failure of the Government to carry out their huge scheme with its wide compulsory powers. The Ministry have now decided to support the voluntary formation of joint authorities which will do their own financing by local or other means. The measure gives new authorities power to raise capital by borrowing money for their undertakings, and will enable local authorities to lend money or assist financially in other ways. The financial clauses are designed to leave the undertakings self-supporting.

Calendars.—From the Sun Electrical Co., Ltd., the well-known electrical engineers and manufacturers, of Charing Cross Road, W.C.2, we have again had the pleasure of receiving a refill of their useful Sunco Desk Calendar, which we can quite understand continues to be appreciated by all users. The Company will be pleased to send a refill to any reader who has not yet received one, but the application must be made on business paper, and will then receive best attention while the stock lasts.——The Keighley Gas and Oil Engine Co., Ltd., calendar for 1921 is, as in 1920, of the daily tear off type, mounted on an excellent cardboard facsimile reproduction of the Company's Gas, Oil and Petrol Engines, and will help to keep the Company's name boldly to the front during what will, we all hope, be a very successful business year.

Higgs Motors.—No. 10, Vol. 2 of Higgs Bros'. (Sand Pits, Birmingham) monthly magazine, starts in fine fashion by announcing a substantial reduction in prices, and goes on to wish a "Higgy" and prosperous New Year to everyone. Other early pages deal with their Brush-Holders and Brushes as well as affording a glimpse of the imposing growth in bulk of the firm's sales ledgers. Then follow the usual tables of prices and stocks, after which we have more humour and some useful hints on windings, although we don't quite understand how an armature can be "burnt out by inspection." Possibly it might be due to a fiery nose or fiery language or even both, but we should like to know a bit more about it, so as to avoid such risks in our own work. Finally the announcement is regretfully made that the price of this very readable little magazine has been raised to 0s. 0d. per annum. Readers are advised to subscribe at once before it goes any higher.

Meetings.—The Inst. E.E. will meet at the Inst. C.E., on Thursday, the 13th inst., at 6 p.m. Subject:—The Twelfth Kelvin Lecture, "Electrons," by Sir William Bragg, K.B.E., F.R.S.——The Junior Inst. of Engineers will meet on Friday, 7th inst., at 8 p.m. Lecturette, "The Indicator: Its Use and Application," by H. G. Pusey (member), Slides. Also on Friday, 14th inst., at 8 p.m., Chairman's Address, "The Tides, their Cause, Effect and Use," by B. E. Dunbar Kilburn, M.A. Slides. Lord Weir of Eastwood, President, in the Chair. And on Friday, 21st inst., at 8 p.m., Lecturette on "Motor Yachts," by Basil H. Joy, M.I.Mech.E., M.I.A.E. All at Caxton Hall. ——An additional informal meeting of the Inst. E.E. will be held on the 24th January, 1921, for the purpose of discussing in what ways the Institution can be made more useful to its members. This will give an opportunity to members who made suggestions at the recent meetings in connection with the increase of subscriptions to put forward their views on the subject. As it is expected that the attendance at this meeting will be larger than usual, arrangements have been made for it to be held at the Institution of Civil Engineers at 6 p.m. (instead of the Chartered Institute of Patent Agents, 7 p.m.).——The First Monthly meeting of the Birmingham and District Electric Club (New Session) will be held at the Grand Hotel, Colmore Row, on Saturday, January 8, at 7 p.m., when the Presidential Address will be delivered by Mr. A. C. Wynne.

Trade Notes.

Bulletin No. 20, issued by **Automatic & Electric Furnaces, Ltd.** (281/3, Gray's Inn Road, W.C.1), deals with the heat treatment of mining drills.

R. B. Hand & Co., Ltd. (63, High Holborn, W.C.1), are issuing a price list of wiring accessories, including cable and accessories, iron clad gear, conduits and fittings. It is intimated that prices will be quoted on receipt of inquiries for A.C. and D.C. motors, switchboards, accumulators, oil engines, ammeters and voltmeters.

From the **Photector Co., Ltd.** (Central Hall, Southall), comes an illustrated price list of electric domestic appliances, including irons, boiling rings, saucepans, bed-warmers, foot-warmers, immersion heaters and electric fires in which "resistance mats" are used. A copy of the list will be sent to the trade by the Company on application.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
FRIDAY, JANUARY 14, 1921.

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SOME ELEMENTARY NOTES ON INSTRUMENT TRANSFORMERS.

BY G. STUBBINGS.

Considering the extensive use of instrument transformers in these present days, when the bulk of the generation and a great part of the distribution of electricity is carried out on the alternating current system, a right understanding of the theory underlying these transformers cannot be put on one side as an unimportant matter by electrical engineers desiring a sound knowledge of the basic principles underlying their work. Notwithstanding this, however, the matter of instrument transformers receives but scant attention in all but the specialised or advanced text-books, and the present paper is an attempt to place before the general electrical reader, in the simplest possible form, the theoretical principles of instrument transformers.

The principle of the ordinary transformer may first be recapitulated. In this machine, it will be remembered, a small primary current will, with the secondary open circuited, suffice to produce a sufficient degree of magnetisation in the iron core to induce by self-induction in the primary winding a voltage very nearly equal to, and in phase opposition to the applied voltage. When current is drawn from the secondary terminals the effect of this current is to demagnetise the iron core, and thus to reduce the back voltage induced in the primary windings, with the result that the primary current is increased till the magnetisation is restored to its former value. If the transformer were without resistance and leakage the back voltage of self-induction in the primary winding would be exactly equal and opposite to the applied voltage, and since the secondary voltage is induced by the same flux, it follows that this secondary voltage would under all conditions of load bear a constant ratio to, and be in exact phase opposition to the applied primary voltage. It is well-known that the effect of internal resistance and of leakage is equivalent in its effect to external resistance and reactance connected in series with the primary of a perfect transformer. When, therefore, an ordinary transformer is working on load it is legitimate to consider that the back voltage induced in the primary windings is equal to the supply voltage, less the drop in the external resistance and reactance, this drop of course being subtracted vectorially. In these circumstances the secondary voltage bears a constant ratio and is in phase opposition, not to the supply voltage, but to the back voltage in the primary windings, and the ratio of the applied to the secondary terminal voltage is not constant at all loads, nor is the phase relationship one of exact opposition, the divergencies from the theoretical exactitude depending both upon the magnitude and power factor of the secondary load.

The requirements of a potential transformer are two-fold. In the first place, the secondary voltage must under all conditions of working bear a constant ratio to the applied primary voltage. Were the office of a potential transformer confined to use in conjunction with potential measuring instruments, or voltmeters, this requirement could easily be satisfied, without any special attention to design, as the accuracy of ratio required would not be of the highest order. The second and more important requirement, when the potential transformer is used to energise the pressure circuits of indicating and integrating wattmeters, is that the phase of the secondary voltage be in exact opposition to the applied primary voltage. If this phase opposition be inexact, the wattmeter will register as if the angle of phase displacement of the current with respecct to the voltage in the main circuit were different from what it actually is. This lack of exactness is of great importance with low power factors, and can cause considerable errors in the indication of the power in the circuit. The reading of the wattmeter will indicate a value of the power corresponding to IV cos $(\phi + \alpha)$ instead of IV cos $\times \phi$, α being the phase angle of the transformer, or the angle between the primary and the reversed secondary voltage vectors. It follows, from elementary trigonometry, that the ratio of the wattmeter reading to the true watts is equal to cos $\alpha -$ tan ϕ sin α. For small values of α and ϕ this ratio is sensibly equal to unity, but, as ϕ increases the value of tan ϕ can become sufficiently large to introduce considerable errors. If, for instance the angle α be 5 degrees, then the error of the wattmeter reading due to the phase angle of the potential transformer will be less than $\frac{1}{2}$ per cent. At a power factor of 0.5, however, this error will be of the order 15 per cent.

The requirements of a potential transformer are, then, a constant voltage ratio and exact opposition of phase between the primary and secondary voltages. Since deviations from these requirements are caused mainly by internal voltage drop in the transformer, and such deviations increase with increase of load, it is easy to understand that a potential transformer should be very lightly loaded. In other words, the rating of a transformer used for energising voltmeters and wattmeters must be a very small fraction of the rating that could safely be assigned on the usual basis of temperature rise.

The general principle of the potential transformer is precisely similar to that of the ordinary power transformer and is easily grasped. The current transformer differs in several respects from these types, and

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a somewhat detailed consideration will probably be useful.

The requirements of a current transformer, it can easily be understood, are practically the same as those of a potential transformer. The secondary current must, under all normal conditions of working, bear a constant ratio to the primary current, and must, moreover, be as nearly as possible, in exact phase opposition to this latter current. In order to understand clearly how these requirements are attained, it will be necessary to consider somewhat closely, the elementary theory of the current transformer.

Consider a current transformer connected up on the primary side in the usual way, with the secondary open circuited, and let an alternating current be passed through the main circuit. This current will induce in the iron core an alternating flux of a value depending upon the primary ampere turns, and this flux will cause a considerable back E.M.F. of self-induction to be set up in the circuit. The primary circuit will, in short, be equivalent to a choking coil connected in the main circuit. Since the flux in the core is also interlinked with the secondary circuit, a voltage will be induced in this circuit equal to the inductive drop in the primary multiplied by the ratio of the secondary and primary turns. If now the secondary winding be short-circuited a current will flow the effect of which will be to demagnetise the core, and if the secondary circuit be of exceedingly low impedance, the demagnetising effect will persist till the magnetism in the core has almost disappeared, sufficient only remaining to induce the exceedingly small voltage required to drive the secondary current against the impedance of the secondary circuit. In these circumstances the primary current can be resolved into two components, the one in opposition to the secondary current, and the other nearly in quadrature, with the secondary voltage, this latter component being required to magnetise the core. If this latter component be of negligible magnitude, as will be the case if the impedance of the secondary circuit be practically zero, and the whole of the primary flux be interlinked with the secondary circuit, it is easy to understand that the primary ampere turns must be nearly exactly equal and opposite to the secondary ampere turns. As the impedance of the secondary circuit is increased, a greater degree of magnetisation of the iron core is required to produce the voltage necessary to produce the necessary secondary current for demagnetising the core. The magnetising component of the primary current will accordingly be increased, and the component producing the secondary current will be displaced in phase with respect to the main primary current. It is also easy to see that, for a given secondary impedance, and a given primary current, a definite degree of magnetisation or, what is the same thing, a definite number of primary magnetising ampere turns are required to produce the secondary current. The magnitude of the magnetising component of the primary current will then depend upon the number of primary turns, and so the phase displacement will be less as the number of primary turns is increased, because the magnetising component of the primary current will be decreased. In actual practice the secondary current is nearly in phase with the secondary voltage. The primary current has then to supply two components, the one in phase opposition to the secondary current, and the one in quadrature with this current. In these circumstances, the effect of the quadrature or magnetising component in causing deviation from exact opposition between the total primary and the secondary current can easily be understood.

From the foregoing it then appears that, in order to reduce the secondary voltage, the impedance of the secondary circuit must be as low as possible, and further, in order to reduce the magnetising component of the primary current, the iron should be worked at low densities and be as abundant in quantity, and further, the primary turns should be as many as possible. A current transformer, therefore, which is required to be used for wattmeters or watt hours meters, should not in addition be used to operate ammeters, or relays, as the additional impedance of these latter will increase the phase angle of the transformer. A small phase angle cannot be expected with a cheap transformer, with few primary turns and a restricted iron circuit, which is used to operate a number of devices in series, as in these circumstances the magnetising component of the primary current must inevitably be considerable.

It is not difficult to understand, although this point was not referred to in the previous discussion, that a high magnetising current will not only cause considerable phase errors, but will also cause a deviation of the exactness of the ratio of the primary and secondary currents from the true value.

Mention has been made of the circumstance that the drop in the primary circuit with an open circuited secondary may be considerable, and that the voltage so induced in the secondary will be greater by a ratio equal to the ratio of the transformer. In actual practice the secondary voltage on open circuit with, say, full load current may be dangerous for the insulation of these windings, which, of course, are designed for very low secondary pressure. Before disconnecting the external circuit from the secondary of a current transformer on load, it is necessary to short circuit the secondary terminals.

There is a further type of current transformer, of totally different characteristics from the type just considered, which is used in connection with wattmeters of Dr. Sumpner's design. The Sumpner wattmeter resembles in many ways an ordinary direct current moving coil instrument, differing from this latter instrument in having an electro-magnet excited from the supply pressure in place of the permanent magnet of the direct current instrument. If the resistance of the magnet winding of the Sumpner instrument be negligible in comparison with the reactance, the magnetic field will be in quadrature with the supply pressure. The moving coil is traversed by a current proportional to the main current, and it is easy to see that these two currents must be in quadrature if the instrument is to indicate true watts. The moving coil of the wattmeter is accordingly supplied from a special current transformer known as a quadrature transformer, the principles of which are worthy of consideration.

Returning to the ordinary current transformer, if the resistance of the secondary circuit be increased, the demagnetising effect of the secondary will decrease and the flux will grow larger.

The increase in the flux in the core could be prevented by increasing the reluctance of the magnetic circuit. As the secondary resistance is increased, the reluctance

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of the magnetic circuit meanwhile being increased to maintain a constant flux, the demagnetising effect of the secondary will become very small, and the magnetising current will be very nearly equal to, and in phase with the main current. In these circumstances we shall very nearly have the flux in phase with the main current, and, in accordance with fundamental principles, the secondary E.M.F. will be in quadrature with the main current. It is now easy to see that provided the secondary circuit is practically non-inductive, the current in this circuit will be in quadrature with, and proportional to the flux in the core. Since the flux is proportional to and in phase with the main current, the secondary current is proportional to and in quadrature with the primary current. The essential difference between a transformer of this type and the ordinary current transformer consists in the fact that with the quadrature transformer the secondary current is exceedingly small, and the demagnetising effect of this current is negligible. The reluctance of the magnetic circuit is made very large by the presence of an air gap and the whole of the primary current is used to magnetise the core, the flux being in phase with this current. It need hardly be said that the secondary of a quadrature transformer can safely be open circuited whilst on load.

The deviations of instrument transformers from theoretical accuracy are a matter of small importance for all devices but wattmeters and watt hour meters. With these latter instruments especially, as high an accuracy of registration as possible is quite essential, especially for consumers' supply meters, and the importance of the matter of phase angle is very considerable. It is for this reason that it is considered good practice to test watt hour meters with their transformers, although this is more difficult than the method of testing the instrument alone, and assuming the instrument transformers to be correct in ratio and to have zero phase angle.

PROGRESS IN LIGHTING.

NEW DEVELOPMENTS IN THEORY AND PRACTICE.

In a paper read before the National Association of Supervising Electricians on December 14, Mr. W. E. Bush (Illuminating Engineering Dept., British Thomson-Houston Co., Ltd.) remarked that a great deal had been written upon the subject of illumination. Yet light had been treated in such a casual manner for so many centuries, that the general public still failed to appreciate the need for careful design in lighting installations and the necessity for scientific methods. There was a difficulty in making people understand this, without abstruse technicalities. The chief feature of modern methods was that we now judged mainly by the amount of illumination provided at the point where it was needed (the "working plane") whereas in the past people had concerned themselves only with the candle-power or efficiency of the lamps used. Yet even the provision of sufficient illumination is not the sole criterion; many other factors, such as the dimensions and system of decoration of the room, position and nature of fittings, etc., had to be taken into account.

Mr. Bush proceeded to explain various technical terms such as mean horizontal and mean spherical candle-power, the lumen, etc., and exhibited a simple form of illumination-photometer enabling the foot-candles to be determined by the inspection of a row of translucent spots of varying brightness situated in a white screen which received the illumination to be measured. He also explained the use of the formula :— Total flux in lumens = Intensity in Foot-candles × area in square feet/Utilisation Factor. The "utilisation factor," *i.e.*, the ratio between the flux of light on the working plane and the total flux of light provided, depends on many factors, notably the reflection of

Reflection Factor: Ceiling			Light 70%		
Reflection Factor: Walls			Light 50%	Medium 35%	Dark 20%
Reflector Type	Light Output	Ratio = Room Width / Ceiling Height			
Prismatic Glass Bowl-Frosted Lamp	90° to 180°—22% 0° to 90°—65%	1	.42	.38	.35
		1½	.50	.46	.43
		2	.56	.52	.49
		3	.63	.59	.55
		5	.70	.66	.63
Dense Opal Bowl-Frosted Lamp	90° to 180°—20% 0° to 90°—60%	1	.41	.37	.34
		1½	.49	.45	.42
		2	.54	.50	.47
		3	.60	.56	.53
		5	.67	.63	.59
Steel Bowl Porcelain Enameled	90° to 180°— 0% 0° to 90°—45%	1	.38	.36	.34
		1½	.45	.43	.41
		2	.49	.47	.45
		3	.54	.52	.50
		5	.59	.57	.55
Indirect Mirrored Glass	90° to 180°—80% 0° to 90°— 0%	1	.22		
		1½	.27	.24	.22
		2	.31	.28	.26
		3	.36	.33	.31
		5	.42	.39	.37
Semi-Indirect Light Opal	90° to 180°—60% 0° to 90°—25%	1	.27	.24	.21
		1½	.34	.30	.27
		2	.39	.35	.32
		3	.45	.41	.38
		5	.51	.47	.44
Enclosing Light Opal	90° to 180°—35% 0° to 90°—40%	1	.23	.20	.17
		1½	.30	.26	.23
		2	.35	.31	.28
		3	.41	.37	.34
		5	.48	.44	.41
Semi-Enclosing Opal Bowl	90° to 180°—30% 0° to 90°—60%	1	.32	.28	.26
		1½	.40	.36	.33
		2	.45	.41	.38
		3	.52	.47	.44
		5	.59	.54	.51

FIG. 1.—TABLE OF CO-EFFICIENTS OF UTILISATION, SHOWING THE EFFECT OF THE TYPE OF LIGHTING UNIT, AND OF LIGHT, MEDIUM AND DARK SURROUNDINGS.

light from walls and ceiling and the nature of the lighting unit, but can readily be estimated when these factors are known. Having obtained the total lumens required, the next step is to decide the size of lamps to be used, their height and spacing, data on which are now published by leading firms. Mr. Bush worked out a typical example and also gave a further calculation showing what a small proportion cost of lighting forms of the total working expenses, in general, less than 1 per cent.

The lecturer also dwelt upon various factors affecting success in lighting, notably efficiency, uniformity of illumination, avoidance of glare, diffusion, etc., and pointed out the advantages of good lighting in diminishing spoilage and improving output in factories.

In conclusion, a number of problems such as the lighting of factories, shops, picture galleries and offices were briefly discussed by the aid of suitable

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illustrations. By the courtesy of the British Thomson-Houston Co., Ltd., we are reproducing a table of co-



FIG. 2.—INDIRECT (" EYE-REST ") LIGHTING IN A LARGE OFFICE.



FIG. 3.—VIEW OF ST. ANNE'S CHURCH, EDGEHILL, LIVERPOOL, LIGHTED BY CONCEALED LAMPS IN " MIRROLUX " TROUGH REFLECTORS.

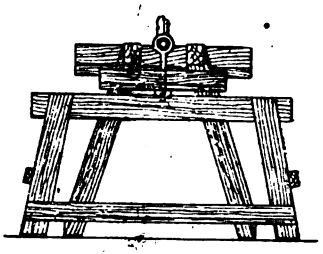
efficients of utilisation, and also two typical views of lighting installations, a church and an office, shown at the lecture.

Improved Electricity Scheme for South Wales.—An important conference has been held at Cardiff to discuss the notice given by the Electricty Commissioners, that they had provisionally determined the area to be constituted a separate electrcity district for South Wales for the purposes of the Electricty (Supply) Act, 1919. There were present representatives from all the local governing authorities. W. H. A. Chamen, electrical engineer, presided. A letter was read from W. Dalziel (South Wales E. P. D. Co.), suggesting the setting up of a co-operative scheme such as the Treforest Electrical Supply Co., Ltd. A strong Committee was formed including several eminent electrica engineers and chairmen of electrical undertakings, to consider alternative schemes and also the linking up ideas put forward several years past.

HOME-MADE EQUIPMENT USED IN BENDING PIPE.

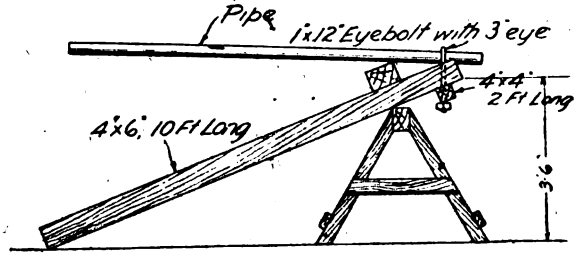
BY ARTHUR S. NICKERSON.

A device found convenient for bending pipe in sizes from 1.25 to 2.5 in. is shown in the accompanying illustrations. The eyebolt is the only piece of metal



End View Showing Two Long Timbers with Eyebolt Between.

required in assembling this equipment, the entire frame being constructed of timber. The horse and timbers are usually readily available on a construction job, so all that the electrician need supply is the bolt and the time to assemble the parts.



Side View of Pipe-Bending Rig.

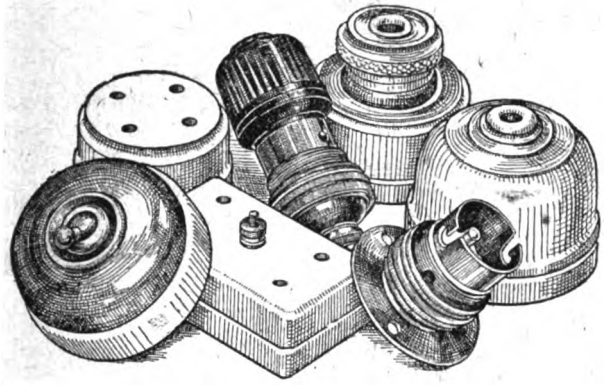
The pipe is inserted through the eye in the bolt and then is pressed down over the cross timber. The length of the bolt and the position of the timber can be carried to suit the radius of the bend desired.—*Electrical Review*, Chicago.

Personal.—Francis J. Bostock, M.I.Mech.E., and Capt. S. Bramley-Moore, M.C., have both left Messrs. David Brown & Sons, and have started on their own as Bostock & Bramley, Consulting Engineers and Manufacturers, Netherton, Huddersfield. With their intimate knowledge and experience of gearing in all its various branches, they have decided to set up as consulting engineers on power transmission. They are also acting as sole representatives for Messrs. Sharp & Preston for North England and Scotland for the installation of their automatic gas and air mixing incorporators for industrial heating under the improved Docknig Patent. In addition to the above, they have some new schemes in hand, but regret that details as to the nature of these new inventions will not be available until March. Both gentlemen joined Messrs. David Brown's & Sons in 1911. Mr. Bostock has held the post of Works Manager since 1914, whilst Capt. Bramley-Moore was pre-war Chief Designer and post-war Technical Publicity Manager. Mr. Bostock's inventions relating to gear cutting machinery have frequently been dealt with in the Technical Press, whilst his special F. J. form of Worm Gear holds the World's Record for efficiency as tested by the National Physical Laboratory. Capt. Bramley-Moore is, of course, known to many thousands of our readers as the author of that eminently practical book, " Motors in a Nutshell," and he is reading a paper before the Institution of Automobile Engineers in London, on Wednesday, Jan. 12th. Mr. E. Gregory, late assistant Works Manager at Messrs. David Browns & Sons, has joined the staff of the new firm as Chief Engineer.

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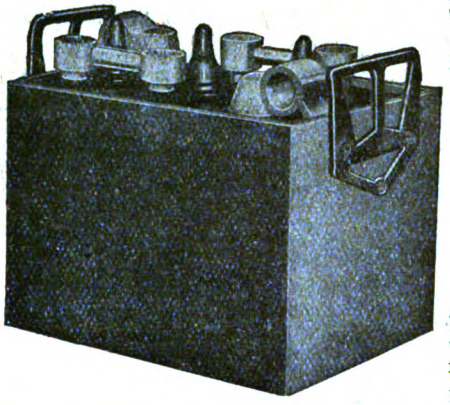
The telephone numbers are { **For Home Sales 442 & 443 VICTORIA.** **For Export Sales 5542 VICTORIA.**

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,, ,, 15	105	12¼ ,, ,, ,,
12 volt ,, 7	45	12¾ ,, ,, ,,
,, ,, 9	60	15¼ ,, ,, ,,
,, ,, 11	75	17¾ ,, ,, ,,

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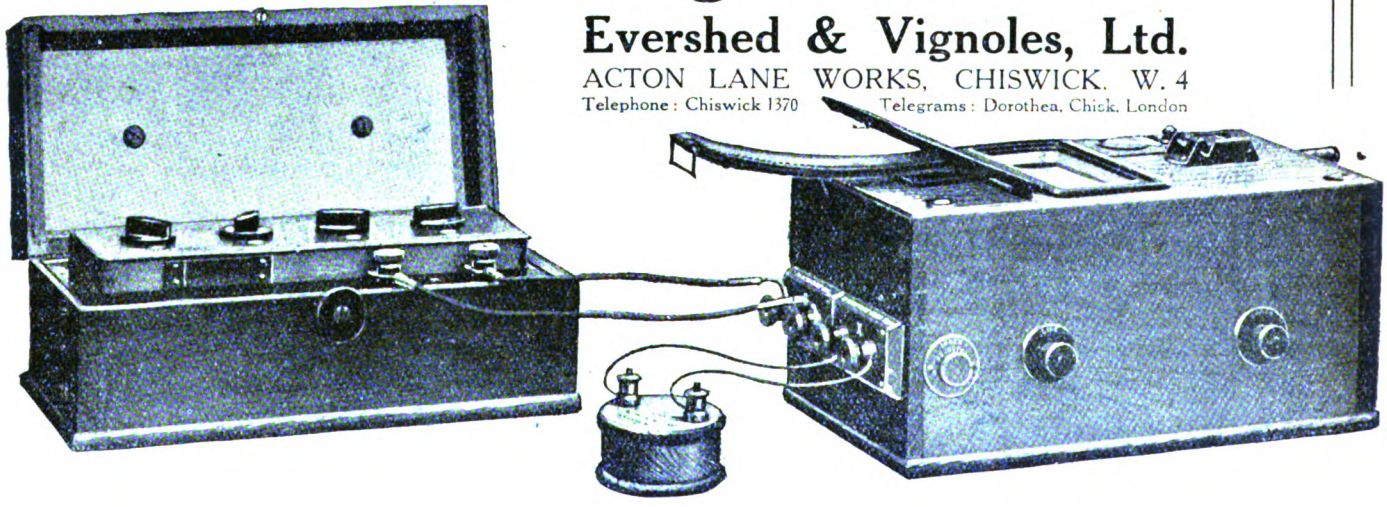
The set illustrated is the "Bridge-Megger" for testing insulation at or above working pressure, and measuring low resistances.

As its name implies, this instrument combines the functions of a Megger Testing Set with those of a Wheatstone Bridge.

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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 38-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

No Money.

The present financial stringency which is affecting industry almost universally aptly illustrates the important part which money, actual cash or securities, plays in our daily life. Obviously it is only a convenient means of trading, and, in the absence of money, we should eventually return to the ancient system of barter, or the exchange of goods to value as a means of livelihood. If the bankers and cosmopolitan financiers who manipulate the world's finances to-day do not soon find a common-sense and equitable solution to the existing state of affairs we shall adopt barter, willy nilly, and money will at once lose its face value. We may be reduced to wiring houses for the price of a suit of clothes or a couple of pairs of boots, and exchanging electric vacuum cleaners for a month's bread supply. Two bottles of whisky for an electric kettle wouldn't be a bad exchange, whilst half a dozen gas-filled lamps for a sirloin of beef suggests endless possibilities.

It isn't that there is no work to be done; no orders on our books, no trade. There is demand in plenty for British goods, but there is not enough loose cash to pay wages and generally finance all the big and comprehensive programmes up and down the country. Unemployment is rife and the war wage spend-thrifts are coming into their own. Although there is doubtless a good deal of genuine distress as a result of the trade slump, there must be many out-of-works to-day who, if they had saved when they were earning big wages, would be well able to tide over the interval of slackness. One cannot work up any deep sympathy for this class as a whole, whereas one's sympathy goes out to the conscientious and consistent worker who was not an opportunist, but just carried on whilst the country was in jeopardy.

Even municipalities are hard hit and unable to borrow money to finance this year's programmes, Birmingham being a recent case in point. In this connection an interesting point has arisen in the course of newspaper discussion. A correspondent of the *Birmingham Post* points out that, whereas small manufacturers, or those with but small demand for electric power, cannot with advantage, either to the city or to themselves, generate the current on their own premises, large manufacturers or big consumers could and would do so. On the other hand, even the large power user in these days of financial stringency, prefers to let the corporation capitalise the plant necessary to produce his power rather than lay out such a sum as £43 10s. per h.p. for his own generating sets. In any event, it is obviously more efficient to pool demands and generate in big units than dissipate thousands of pounds in laying down a large number of comparatively small generating units. Moreover, if the supply undertaking is properly managed the ratepayers as a whole derive ultimate benefit from the common or co-operative scheme.

Strikes Ill-timed.

In the shadow of the trade slump and increasing unemployment one would have thought that the strike fever which has been prevalent throughout the year just ended, would have abated. According to latest reports, however, those workers engaged in the manufacture of electric lamps, batteries and accumulators are agitating for higher wages. Convened by the National Federation of General Workers, a conference of representatives of affiliated unions was recently held to consider the wages of these men, several thousands of whom in London, Manchester, Sheffield, Birmingham, Newcastle and other centres are affected. It was decided to make application to the Engineering and National Employers Federation for an extension to the workmen concerned of the rates and wages obtaining generally in the engineering trade. A conference has also been held at York to discuss a similar claim on behalf of the women workers in the trades specified. Whilst the rights of Trades Unions are indisputable, it behoves Labour generally to moderate its demands if the general trade of the country is to revive in the near future.

A Healthy Sign.

In contradistinction to the disaffection which made us all glad to say good-bye to 1920, there is one noteworthy example of the encouraging results which are obtained when masters and men work together in a spirit of goodwill and mutual interest. The Cornish tin mining industry is suffering from depression consequent upon the fall in the price of tin. The workmen employed by the Tincroft Mines, Ltd., Redruth, recognising the difficulties which the directors are faced with, have voluntarily offered to contribute £200 per month in order to keep the mines working. In addition, they have sent a letter to the directors enclosing a copy of a resolution passed by the workmen, in which the latter express gratitude to the directors for keeping the mines going, promise to do their utmost to increase production, and end up by wishing the board the compliments of the season. That's the stuff to give 'em!

The Rivals.

As between gas and electricity there is always healthy competition where the two undertakings are under separate control. A recent example of this friendly rivalry, making for the ultimate benefit of consumers of both commodities hails from Macclesfield, where Councillor Hyde, at a recent meeting of the Town Council, moved as an amendment to the Gas Committee's minute that certain premises recently acquired by that committee as showrooms should not

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be opened for the present. The amendment was defeated. The arguments used by Councillor Hyde were that the showrooms would not make an adequate return on the money they proposed to spend; also that it would be an encroachment on the business of gas-fitters and others trading in the vicinity.

As against this view, Councillor Pimblott said it was their duty to increase the consumption of gas, and the showrooms would materially aid in this direction. If they were not careful they would have the Electricity Company overtaking them, and it would then be a question of making less money, and the rates would suffer accordingly. Alderman Frost said it did not follow that because they were not spending money they were necessarily economising. In all successful businesses it was necessary to spend money in advertising in order to get a return. Councillor Thompson said if the Council did not proceed with the project he felt sure the Electricity Company would only be too glad to buy the premises and exhibit their wares instead.

The Noises of Industry.

A certain amount of noise is inseparable from machinery and industrial processes, but, in the interests of the public at large it behoves responsible officials and the managers and engineers of all works to reduce these noises to a minimum. A recent case which figured in the daily Press for some time was associated with the objectionable screaming of a high-speed circular saw. The unsilenced explosions of high-power gas-engines, the thud of steam hammers, the tapping of hydraulic riveters, and many other distinctive noises are extremely nerve racking to innocent residents in the vicinity of works where these processes are carried on, and quite a recent case is that of Bradford Corporation electricity works, where a buzzing or whirring noise is complained of by the residents for a radius of about a mile. The discomfort of this noise obtains at night as well as by day, and is largely influenced by the direction of the wind.

All noise is due to vibration of high or low frequency, and with the growth of engineering and other industrial works it would appear that there is room for scientific research directly aimed at the suppression of unnecessary noise without detracting from the efficiency of the processes which give rise to it. A good deal has been done already in connection with the silencing of internal combustion engines, the mounting of reciprocating machinery on anti-vibration foundations, etc., but much still remains to accomplish if we are to enjoy peaceful residence in neighbourhoods adjacent to industrial centres. I offer the suggestion to consulting engineers and others as opening up a new and promising field for kudos and profit.

ELEKTRON.

A Correction.—We regret that by an error on the part of our printers, the block of the Sunlight "P. E." reflector figure 1, in the article on High Efficiency Lighting on page 4 of our issue of January 7th, was inserted upside down. It was in its proper position when passed in proof but was lifted from the machine for adjustment and afterwards put back wrongly. We expect that many of our readers must have smiled at the absurdity, and we can but express our regrets.

ELECTRICAL ENGINEERING, GRADE II.

C.C. WORK.

Solutions to Questions set at the 1920 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page 10.*)

Q. 9.—Explain how the efficiency of two similar transformers may be found by a back-to-back test. What arrangement may be made to vary the power factor of the circulating current?

A. 9.—Let T_1 and T_2 in Fig. 8 be the two similar transformers to be tested. The high-tension windings are joined together, whilst the low-tension winding of T_2 is connected directly across the mains, and that of T_1 is connected in series with a switch S, a wattmeter W_2 and the secondary of an auxiliary transformer

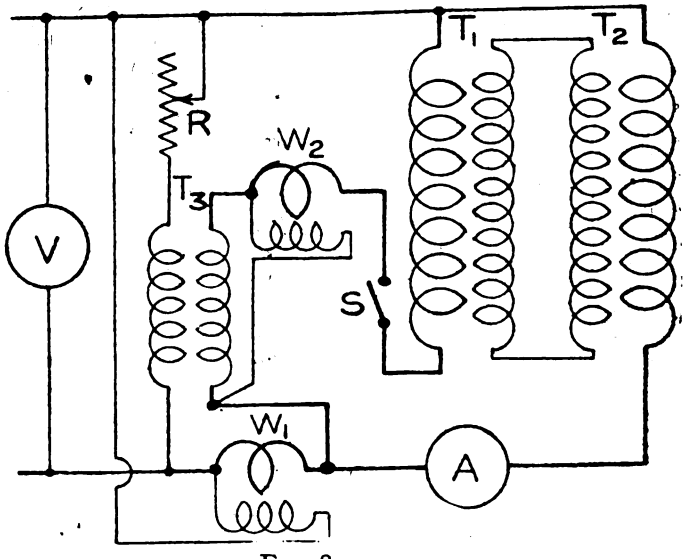


FIG. 8.

T_3. Precaution must be taken to arrange that T_1 and T_2 shall be acting in opposition relatively to each other, and the simplest way of checking this is to disconnect the primary of T_3 from the mains and connect a voltmeter across S. This voltmeter should then read zero. To ensure that the zero reading is not due to a faulty instrument or a broken circuit, it is advisable to note the voltage across S after the primary of T_3 has been reconnected to the mains. Ammeter A, voltmeter V, and wattmeter W are also inserted in positions indicated in Fig. 8.

When switch S is open, the two transformers T_1 and T_2 are excited from the primary of the latter, the total magnetising current being indicated on A, whilst W_1 gives the total power taken. With the correct terminal voltage, the fluxes and therefore the iron losses in the cores of T_1 and T_2 are at their normal values, but the magnetising currents are so small that the I^2R losses are negligible in comparison with the iron losses, and therefore the latter can be taken as being equal to the power indicated by W_1.

Switch S is next closed and the resistance R is adjusted to produce full-load current—indicated by A around T_1 and T_2. Since the terminal voltage is

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maintained constant, the iron losses remain practically the same, and the extra power for the I^2R losses in the two transformers has to be supplied by the secondary of T_3, and will therefore be measured on wattmeter W_2. Wattmeter W_1, whose deflection remains practically unaffected, still gives the total iron losses.

Since T_1 and T_2 are operating under almost the same conditions, the losses can be divided equally between them, so that for a load having a power factor of cos ϕ,

$$\left.\begin{matrix}\text{Efficiency of}\\ \text{each transformer}\end{matrix}\right\} = \frac{IV\cos\phi}{IV\cos\phi + \frac{1}{2}(W_1 + W_2)} \times 100$$

The terminal voltage of the secondary of T_3 has to overcome the equivalent impedance of the two transformers T_1 and T_2, and the circulating current will have a definite phase relationship to this voltage depending only upon the equivalent resistances and reactances of the windings. Also, the voltage across end of current in the primary of T_3 will bear definite relations to the secondary values; but the phase relationship between the supply voltage and the voltage across the primary of T_3 can be altered by inserting a variable reactance in series with R. No advantage, however, would be gained by altering the power factor of the load, since for a given current and voltage, the losses and therefore the wattmeter readings would be unaffected.

(To be continued.)

TEN BUSINESS COMMANDMENTS.*

1. Thou shalt not wait for something to turn up; but thou shalt pull off thy coat and go to work, that thou mayest prosper in thy affairs and make the word "failure" spell "success."

2. Thou shalt not be content to go about thy business like a tramp, for thou shouldst know that thy personal appearance is better than a letter of recommendation.

3. Thou shalt not try to make excuses; nor shalt thou say to those who chide thee, "I don't think."

4. Thou shalt not wait to be told what thou shalt do; nor in what manner thou shalt do it, for thus may thy days be long in the job which fortune hath given thee.

5. Thou shalt not fail to maintain thine own integrity; nor shalt thou be guilty of anything that will lessen thine own respect for thyself.

6. Thou shalt not covet the other fellow's job; nor his salary; nor the position he has gained by his own hard labour.

7. Thou shalt not fail to live within thine income; nor shalt thou contract any debts which thou canst not see thy way clear to pay.

8. Thou shalt not be afraid to blow thine own horn, for he who faileth to blow his own horn at the proper occasion findeth nobody standing ready to blow it for him.

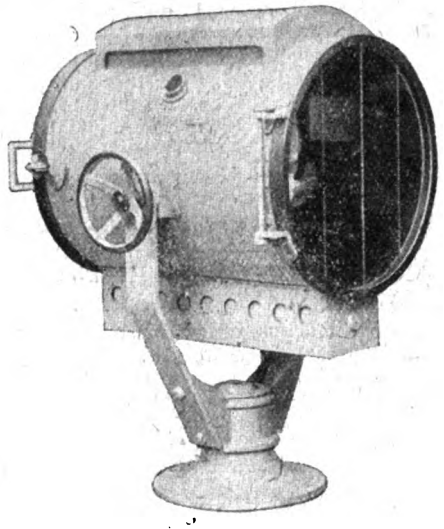
9. Thou shalt not hesitate to say "No," when thou meanest "No"; thou shalt not fail to reme that there are times when it is unsafe to bind thyself by a hasty judgment.

10. Thou shalt give every man a square deal. This is the last and greatest commandment, and there is none other like unto it. Upon this commandment hang all the laws and profits of the business world.—ANONYMOUS.

* *Katipo*, Wellington, N.Z.

SEARCHLIGHTS FOR STUDIOS.

The accompanying illustration shows a searchlight, which is used for studio illumination, including back and spot lighting—one of its special features being the high actinic value of the light. Also the angle of the beam is within the control of the operator, and therefore the field of illumination is variable to suit different requirements. It is not the ordinary closely defined pencil beam but is somewhat diffused owing to the special reflector employed. The projector is of extreme simplicity, both as to its construction and operation, and is also very robust to withstand rough usage. The training and elevating movements are very facile, and the lamp is made for either hand or automatic working. A searchlight of this class is more usually used on D.C. circuits as the carbons are arranged horizontally, but the lamp can be suitably modified to burn on alternating cur-



rent when necessary. Various attachments are supplied, including shutters and Iris diaphragms, also dispersing lenses of various kinds. When a clearly-defined beam of light is required the same searchlight fitted with an alternative type of mirror can be employed.

Various sizes of this projector, fitted with mirrors from 14 in. diameter and upwards, 18 in. being the average size used, are made.

We are informed that demonstrations can be given at the works of the London Electric firm (Brighton Road, Croydon), or machines will be sent to prospective customers' studios. The searchlights are, if desired, fitted with extensive tripod stands, and the controls for the lamp brought within reach of the operator on the ground.

DOMESTIC ELECTRICAL COOKING AND HEATING APPARATUS.

A comprehensive range of domestic electrical cooking and heating apparatus is contained in List No. 314, recently issued by the Sun Electrical Co., Ltd., 118-120, Charing Cross Road, W.C.2. First there is the excellent electric iron, weighing 5 lb. and loaded to 450 watts. Among its features is an ingenious attachment to eliminate the necessity for using a separate stand; when placed on end the hot sole-plate is clear of the table and work and can do no damage. Various "universal" irons, kettles, tea-pots, table cookers, etc., are also listed, as are Xcel kettles, double cased cookers, etc. Of special interest, perhaps, is

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the Xcel table cooker illustrated. Finished in nickel plate, it is supplied complete with one deep pan, lid (or deflector), grid and connector. As grilling, frying, toasting and boiling can be carried out, a complete meal, such as breakfast can be cooked on the table for three or four people—a great convenience in many cases. Other items listed are the well-known "Sunco" electric vacuum cleaner, vibrator sets and hair dryers.



XCEL ELECTRIC TABLE COOKER IN USE SHOWING FRYING AND GRILLING BEING DONE AT THE SAME TIME.

Correspondence.

ELECTRICAL MEASURING INSTRUMENTS.

To the Editor of ELECTRICITY.

DEAR SIR,—In the article under this heading appearing in last week's issue of ELECTRICITY, several different types of instruments are dealt with, and certain explanations and proofs given. It appears to me, however, that some of the points are not very clear! If "L. S." would give a little more detailed information I, and perhaps other readers, would be grateful.

In the first instance the trigonometrical expression at the commencement appears to be somewhat mixed; it is not clear as to why O.G. = the force of gravity; or why O.G. = O.B., ought not it to be A.G. = O.B.?

Is not the "restoring force" to a state of equilibrium or equipoise, usually known as the Resultant?

In the article the expression that the instruments follow a "Square" law is repeatedly used. An explanation showing exactly what is meant by "Square" law would have been helpful.

Fig. 3 shows a repulsion type of instrument, and it is stated "This repulsive force will be proportional to the strength of the induced poles." Will this be correct in the case of the instrument shown in Fig. 3? If so, what of the law representing the distance between poles! "And this scale will follow a 'square' law."—Is this it?

In the instrument shown in Fig. 4 "this field will attract the drive into the bobbin by an amount proportional to the current," and yet "*The scale obeys a 'square' law.*" If the movement is proportional to the current, why does the scale obey a "square" law?

The detailed parts of the moving coil instrument are given, together with some theory of the instrument:—the force acting being given by the expression:

$$F = \frac{H L C N}{10} \text{ dynes,}$$

when H is defined as being "Field produced by the permanent magnets." But is this sufficient definition for "H"?

In the above expression $\frac{H L N}{10}$ is stated to be a "constant number"; and, with "H" sufficiently defined, in a well designed instrument I agree; but I venture to suggest that as the instrument is described "*H" will not be a constant,* and therefore the scale will not be uniform.

Trusting the above few remarks will elicit some further matter of interest to your readers.—Yours faithfully, W. J.

ARMATURE WINDING (TESTING).

To the Editor of ELECTRICITY.

DEAR SIR,—"It is for the benefit of such electricians that these few notes are written."

Thus says Mr. Sylvester in an article published under the above heading in a recent issue of ELECTRICITY.

The said electricians being those poor "average electricians" in charge of isolated power plants who, "irrespective of lack of instruments, lack of ability, lack of knowledge, in fact, men who really would not be expected to know everything about armature winding," these men are still expected to keep their plant in running order.

By what right, sir, has Mr. Sylvester to make such a statement respecting men of his own class? What would be his feelings if someone made such statements respecting his journalistic efforts?

It is true Mr. Sylvester extends his sympathy to this poor fellow, thus adding insult to injury.

The "average electrician," in charge of plant, can and does keep his plant in good repair, in spite of its being an "Art" and requiring a number of years to become an expert. As to whether they adopt Mr. Sylvester's methods of testing is quite another matter.

Let us examine what he says:—

"To the *average electrician* all armatures look alike . . . . and the testing *should* only be carried out if the circuits are in the mind's eye." Poor *average electrician.*

Still there is hope, for have they not the sympathy of Mr. Sylvester? And is he not prepared to lead them out of their troubles and difficulties? To this end an explanation is given of the lap-wound armature and, coming to the testing "*you simply balance the armature with a Wheatstone Bridge . . . . and the result should be the same.*" Quite simple, no explanation required, in fact it's as simple as shelling peas.

Again:—

"As it will be easy to ascertain the resistance of any one coil by balancing."

As one of the A.E., will Mr. Sylvester kindly come down to our level and explain how this easy thing is done?

Again:—

"The result of a balance in this case should be equal to the joint resistance of one quarter and three quarters of the coils in parallel."

This to the poor fellow who does not know one armature from another.

"From these remarks . . . . are in the mind's eye . . . . the type of winding may be determined *and if it is healthy or not.*"

I have me doots, Mr. Sylvester.

Wave Winding.

"Here it will be seen that to obtain the resistance of one coil it will be necessary to balance between segments 1 and 31."

Again we plead for information.

"The difference in the two windings . . . of adopting *sure* methods when carrying out a *drop* test." Sure, Mr. Sylvester, sure?

But will you tell us at what stage of the article you dealt with the "drop" test?

"In a *lap-wound* armature . . . . which are diametrically opposite to each other."

Sounds O.K., Mr. Sylvester, but what must the poor fellow do if it happens to be wave-wound?

Several other points are in my mind, but my letter is

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
FRIDAY, JANUARY 21, 1921.

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BY THE WAY.

When one takes stock of one's store of reminiscences it is surprising to find how many of these centre on the technical ignoramus. We are all as ready to laugh at the coloured gentleman who proclaims himself an "Electrict and mortor repairer," and who talks of a "short shirt on the line," as we are of the rash fellow who pours a bucketful of water on a smoking dynamo that is still generating. To the cynic our attitude is ridiculous, because, as he points out, we would be equally big fools were we to venture into non-electrical domains. And, of course, he is quite right!

Personally, the writer would often prefer an intelligent amateur to many a so-called professional. A specimen of the latter came to his notice a few days ago—typical of the numerous "electricians" who are masquerading amongst us to-day. He had wired a house, and, with the usual test, the insulation to earth should have been about .8 megohm at least. The Supply Company's inspector found it to be less than .3. This was pointed out to the "electrician," who said that he knew nothing about megohms or insulation testing, but that everything had been all right on a bell-and-battery test! "Where ignorance is bliss——"

This reminds me of an unofficial visit to a kinema where the "juice" was generated *in situ* by a fairly large gas-engine set. The first thing that struck the writer was the enormous amount of oil which was present—it lay everywhere. The operator explained that plenty of oil ensured sweet running, the surplus naturally being flung out from the bearings. (The writer's rainproof bore pitiful evidence of this.) The operator then switched off the light and impressively pointed out an astounding display of flashes on the "com." of the dynamo. "That's 'lectricty—same sort of thing as lightning, you know," he explained in awe-inspired tones. The brushes had a lag of about 2 inches, and, of course, the commutator was receiving its due share of oil!

Mention of that kinema reminds me of another bioscope operator whom the writer met in the Army. This chap was rather proud of the fact that he had mastered "Ohm's Law"—so proud that one day he insisted on explaining it to the ignorant writer, forsooth. Here is his explanation:—"Now, if you have *one* volt and *one* amp. that means you have a resistance of *one* ohm in your circuit. No one can deny that. Well, in my 'box' we ran at seventy volts, seventy amps. From that I reckon my resistance as seventy ohms!" After the writer had duly digested this original contribution to electrical science, he asked whether, with fifty volts and fifty amps., he would get fifty ohms. The Ohm's Law expert replied that that was so, and he delightedly congratulated the writer on his rapid grasp of the principle.

Those readers who had any experience in Army technical units will quite credit the following account of a certain R.E. sergeant. The latter's technical pre-war history was very vague, but he was transferred fom the infantry to take charge of a workshop section. He always carefully avoided tackling problems, deputing these to humble sappers. Q and I Detectors and M.Q Tabloids were used respectively for electrical and photographic work, and it was always enjoyable to hear the noble sergeant refer to "M and Q Detectives" and "Q and I Tappers." Sergeant once tackled a resistance test and reported as follows (this is a facsimile): "The only way I have for testing this rheostat is through an ampmeter and it takes .8 of an amp. with 12 volts on, so that makes it 14.8 w.!"

This reasoning is rather like that of the professor who was manipulating his slide-rule. "Four divided by two," he said, "Er—one point nine, nine, nine—oh, call it two!"

The writer once came into touch with an Army wireman—or rather, linesman—who wired an extemporised workshop in what he called a new and economical method. He put *all* switches and lampholders in series, thus dispensing with about half the usual quantity of cable. The writer remembers this incident so clearly because he was the unfortunate individual told off to pull down the "new and economical" installation—"unfortunate" because the switch blocks were each held in place by two 6-in. nails!

Whilst at the Front the writer was connected with an electrical method of locating the enemy guns. One day a staff officer of high rank appeared on the scene, evincing great interest in the apparatus. The writer's own officer thereupon began a lengthy explanation of the somewhat intricate ranging method, his hearer intelligently interjecting "Hum," "Oh, yes" and "By Jove!" just at the right moments. After the demonstration was concluded and the lecturer was recovering his breath, the staff officer feelingly commented: "Wonderful! Wonderful! I say, *how on earth do they get such a brilliant shine on this mahogany?*"

In the extemporised workshop already referred to a small Austin generating set (of the portable type) was used to drive light overhead shafting, a couple of old iron pipes leading the "exhaust" to the fireplace and up the chimney. One day the shafting-belt left the dynamo pulley and the engine raced—in more senses than one. It left its place and began to dance about on the uneven floor; the exhaust pipes having been left behind, the workshop rapidly filled with choking fumes. It was a case of "wind up," and everybody fled. The situation was saved by a daring fellow who braved the fumes, turned off the runaway's petrol and tottered back to the fresh air.

A similar incident once occurred with a slow-speed oil engine driving a heavy-current generator. No doubt it became fed-up with the monotony of existence, for one day it suddenly burst its bolts and leaped from the bed, and next moment the man in charge was astounded to see it tear through the side of the hut and career down the field on its two flywheels. I think that engine-driver must have been a hard taskmaster, because another of his engines also revolted. On this occasion he was leaning against the wall outside the engine-house, when half of the one-ton flywheel burst through amid a shower of bricks, jumped across the road and dived into a pond. The engine-driver was particularly upset, because he had just lavished a new coat of green paint (with yellow stripes) upon that same flywheel.

One of the writer's acquaintances boasts of his "downrightedness," but that is all he can boast about, for that self-same quality has continually impeded him—you must be a diplomat of sorts if you wish to be a success, and you can't be both diplomatic *and* "downright." In one of his many past jobs (most of which he lost owing to sheer "cussedness") he had to use a dynamometer watt-meter which was very susceptible to stray fields. Now, there was a

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large generating set next door to the room, and this caused trouble with his readings. Instead of making a direct report about the matter he spent a couple of hours tracing out the stray lines of force and chalking nice lines and arrows on the bench. He then summoned his "boss." The latter, much to our friend's disgust, did not appreciate his method of complaining, but became exceedingly abusive.

Anon our friend found himself in a compass works and in charge of a number of girls. Erratic results in the testing of compasses gave him a lot of bother until it occurred to him that the cause lay in a certain (magnetic) article of attire much favoured by the ladies. In his downright way he gave instructions that the wearing of the said article of attire must cease forthwith. Of course, there was an uproar.

This reminds the writer of a somewhat similar effect which occurred in his experience. He had just balanced a form of inductance bridge (the actual coil having an air-core) to an accuracy of about .02 per cent. when a girl-winder walked up to the bench—the beautiful balance at once vanished! But the real cause did not occur to the writer until he had spent some time trying to locate stray fields and magnetic substances.

There must be many stories of meter tricksters, though probably people fight more shy of the electric meter than of the gas meter. In one case a meter replaced several times showed that the error did not lie in the metering; the source of error was eventually found to be a shunting wire carefully connected across the leads inside a run of casing. In another instance—that of a cobbler's shop—there was obviously low metering; the meter was a polyphase one, the power supplied was for a motor, and it appeared that neighbours complained of the motor being run all night. With these clues it was at last gathered that after the day's work was done the wily user left the motor switched on, but with one of the meter phases reversed—thus running the meter *back*.

But the most remarkable artifice is that of the "Heathen Chinee" who bored a fine hole in the meter-case and inserted a hair in such a way as to impinge on the rotating disc. This ingenious "stunt" was not discovered until the meter was dismounted and examined in a strong light.

G. E. M.

A NOTEWORTHY EXAMPLE OF EFFECTIVE SHOP-WINDOW ILLUMINATION.

The fundamental rule that in order to see clearly and comfortably the light should be on the object and not in the eye is still frequently neglected in the artificial lighting of shop windows. Any shopping street in the country will provide many examples of lighting which is ineffectual—not because it is insufficient or of poor colour, but because the lamps are placed so that they shine into the eyes and fog the vision of those who look into the windows. To fill a window with attractively arranged merchandise and then to light it in such a way that the goods can only be seen (and then not clearly) by subjecting the delicate optic nerves to the assault of brilliant and unshaded electric lamps is obviously absurd. Yet this is exactly what a great many shopkeepers do. In arranging the lighting of a shop window it should be borne in mind that the light units themselves should be invisible, since, as they are not for sale, there is no object in making them the centre of attraction, and that all the light should be concentrated on the display, none being wasted on the pavement or directed into the eyes of prospective customers. The glare and dazzle caused by brilliant lamps fixed in the field of vision are not only harmful to the eyes, but actually lessen the power to see.

A good example of the proper way to light display windows is afforded by the recently completed installation at the stores of Messrs. Buntings, Limited, of Norwich. The equipment, consisting of "X-ray" mirror glass reflectors and Mazda Gasfilled lamps, was supplied by the British Thomson-Houston Company, Limited, of Rugby, while the whole of the wiring

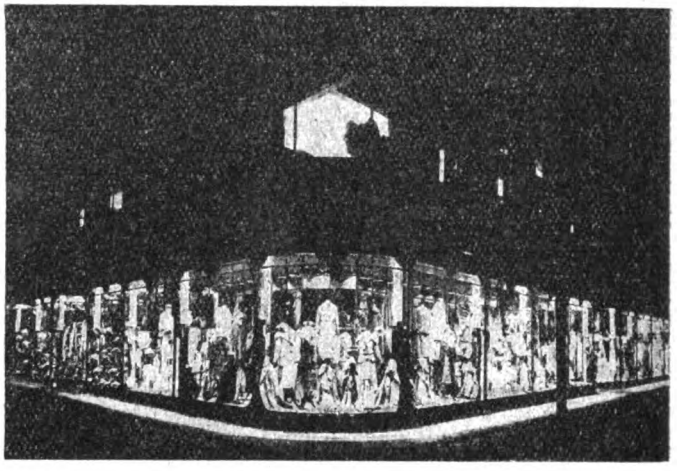


FIG. 1.—GENERAL VIEW OF MESSRS. BUNTINGS' WINDOWS.

erection work was carried out by the Norwich Corporation Electrical Department under the personal supervision of Mr. R. A. Lower. Figs. 1, 2 and 3 give some idea of the effect, but naturally much of the actual effect is lost in reproduction.

In the "X-Ray" system the units are fixed along the top front edge of the window (the only position where full concealment is possible), the reflectors being themselves so shaped that all the light is thrown down and back on to the display. The frontage of Messrs. Buntings' premises has a total length of 190 ft., the windows themselves varying in depth (back to front) from 3 ft. 6 in. to 12 ft. In designing this installation it was necessary to take into account the fact that the upper half of the background was clear glass, and it was considered desirable to prevent any direct light from the "X-Ray" units being projected into the

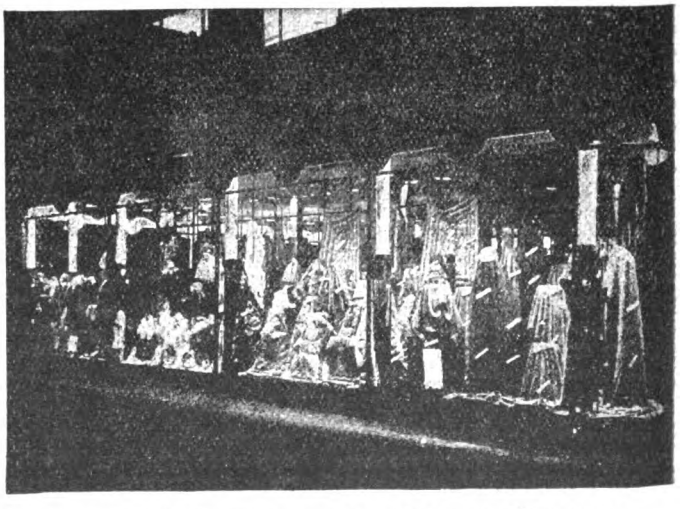


FIG. 2.—A SECTION OF THE DRAPERY WINDOWS.

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interior of the shop. Thus it was necessary to use a reflector which should cut off the light half-way up the background. "X-Ray" reflectors of the "Jupiter" type were adopted, because they possess the right conformation for this purpose. A good idea of the arrangement of the light units may be gained from Fig 4. The reflectors are spaced 2 ft. apart in the deepest windows and 3 ft. apart in the shallowest. They are fixed close to the ceiling and to the window front, with the mouths pointing down the back. A narrow curtain of decorative appearance is fixed between the reflectors and the window in order to hide them from the view of people in the street. In all, eighty-three "X-Ray" reflectors and a similar number of 100-watt Mazda Gasfilled lamps are used in this installation.

The Illuminating Engineers' Department of the British Thomson-Houston Company, Ltd., will be glad to give interested readers further information on the "X-Ray" system of window lighting—a system which has already been installed in many large shops and department stores in London and the provinces. Requests for information should be addressed to this department at 77, Upper Thames Street, London, E.C.4.

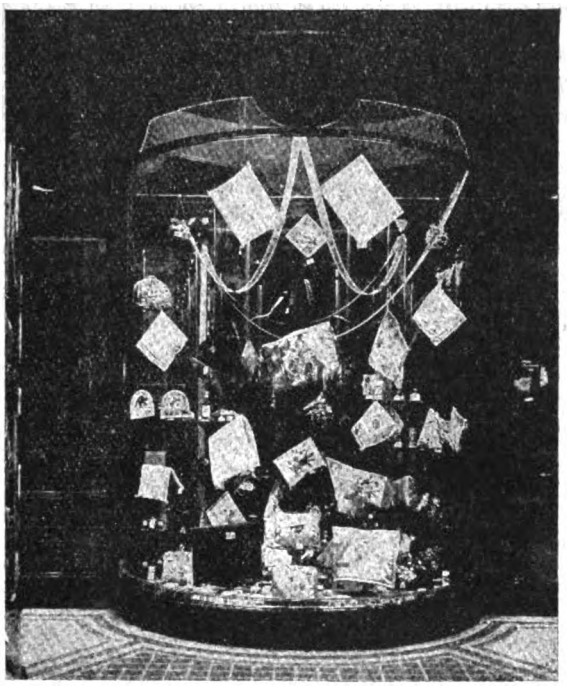


FIG. 3.—A FANCY GOODS WINDOW.



FIG. 4.—PLAN OF MESSRS. BUNTINGS' WINDOWS. The dots represent the "X-Ray" reflector units and the spacing distance for the several sections of the window are noted in the diagram. Inset left shows the "X-Ray" reflectors ("Jupiter" type) employed. Inset right shows a section of the window on the line A—B.

THE ANNUAL DINNER OF THE N.A.S.E.

On Saturday, January 15th, the N.A.S.E. held their annual dinner at the Holborn Restaurant. Members met in the Phœnix Saloon at 6.30, and proceeded to the Venetian Chamber at 7 o'clock to the dinner. The whole of that fine room was filled by the merry crowd of members and visitors, who proceeded to enjoy a most convivial evening. Mr. Highfield performed the hat trick, and took the chair for the third time to the entire satisfaction of all present. After an excellent repast the chairman rose to toast "H.M. the King," which was celebrated with musical honours. An excellent musical programme was interspersed with the rest of the speeches. Mr. Whittley proposed "The Health of the President," and mentioned how proud all were to see him in the chair, and what an able leader of the N.A.S.E. he had always been. Mr. Highfield then responded, suitably and also humorously. Later, Captain Masters made a most entertaining speech, in which he wished the Association every prosperity in the future, though warning them against the possible control of the industry by the members of the fair sex. Mr. Revel, who answered this, told us that he was very sorry to have to mention that Mr. Bannister, who had looked after them for so long, had been advised by his specialists to retire, and therefore was reluctantly resigning the secretaryship in February. All were very sorry to hear this. He also mentioned that, although the Association had had to form themselves into a trade union, and had had some rough times, they were now on a firmer basis, and looked into the future with confidence. Mr. Windybank toasted "The Press," telling us that he was disappointed because we failed to find him £100 bargains with a 50 per cent. discount, and that it would be more cheerful if we obtained T. Webster to illustrate current topics. He concluded, however, by admitting that the Press had their uses, and that the Association thanked them for previous support. Mr. Allen, replying for the Press, said that the N.A.S.E. had always been the best-behaved of unions, and deserved to progress in the future. "The Visitors" were eloquently toasted by Mr. Stylie, and a suitable reply was given by a gentleman whose name the writer failed to catch. The dinner was brought to a cheerful conclusion by the whole party joining hands and singing "Auld Lang Syne."

Barrow.—The T. C. has decided to refer back a proposal that necessary steps be taken to obtain a provisional order from the Electricity Commissioners for powers to proceed with a scheme for the utilisation of the river Leven at Backbarrow for power purposes, and that a consulting engineer be engaged to submit to the Committee a report upon the scheme.

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DEVELOPMENTS IN PRINTING TELEGRAPHS AND TELEPHONE REPEATERS.

LEADING FEATURES OF THE LATEST WESTERN ELECTRIC EQUIPMENT.

(*Concluded from page 28.*)

This risk is overcome by the two-way, two-element circuit illustrated in Fig. 6. A separate repeater element is provided for transmission in each direction and in each bridge circuit each line is balanced by an artificial line instead of by the other line. The degree of amplification possible is

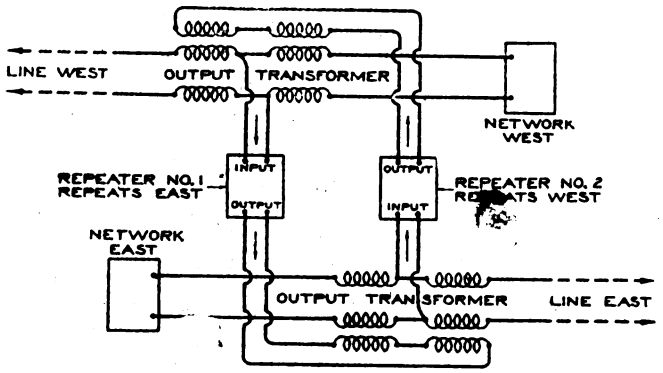


FIG. 6.—WESTERN ELECTRIC "22-TYPE" TELEPHONE REPEATER CIRCUIT (SIMPLIFIED).

now determined by the accuracy of balance between each line and its respective balancing network.

For moderate distances the two-wire system illustrated in Fig. 5 is satisfactory, but for long distances the main transmission is by a four-wire circuit (one line being used for transmission in one direction and the other line being used for transmission in the other direction). The arrangement will be understood by imagining Fig. 6 to be drawn out so that the lower part of the diagram is some hundreds of miles away from the upper part. "Line west" and "line east" then represent the two-wire terminal circuits and are both comparatively short. More than one one-way repeater may be used in each half of the 4-wire line and each repeater is equivalent to a reduction of losses equal to those in 20 or 30 miles of standard cable. A phantom circuit can be operated if required in the main 4-wire section.

It might be thought that the 4-wire line required by this system was very extravagant, but this is not so because the individual conductors in cables used with this system may be as light as 20 lb. per mile. It is physically possible to establish telephonic communication on this system between London and Rome using 20-lb. conductors, and it is safe to prophesy that where there is much traffic the repeater system in conjunction with cables will replace overhead conductors (the latter being 175 lb. or heavier per mile). The New York to San Francisco line uses 435-lb. conductors and started with three repeaters and heavy loading. Now, however, the loading coils have been removed and 12 repeaters are used. The perfection of repeaters means that the day of loading aerial telephone conductors is practically past. Cables will, of course, continue to be loaded to avoid distortion.

From demonstrations with a 2-wire system equivalent to 38 miles of standard cable and reduced to 14 miles by repeaters, and with a 4-wire system equivalent to 72 miles and reduced to 11 miles by repeaters, we can vouch for the practical efficacy of the W.E. repeater sets.

In concluding these notes, mention must be made of certain testing equipment developed for use with this system. Test instruments and keys on the repeater panels are arranged so that all routine tests and adjustments can be effected with a minimum of delay, and indicating instruments and dials are arranged so that the miles of standard cable gained by the use of the repeaters can be determined quickly by instruments, with less trouble and greater accuracy than possible by the old method of shunting a telephone to obtain equality of result with and without repeaters.

We were particularly impressed by an oscillation generating set which, again using the ubiquitous three-electrode vacuum tube, yields testing current at any frequency from 200 cycles up to 4,000 cycles or even 20,000 cycles. This generating set is so designed and constructed that it may fairly rank as a precision instrument yielding a definite output for definite settings, practically independent of the particular tube used and of the load supplied.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 109.

I have a motor starter with the resistance burnt out. It is 40 horse-power, 440 volts. How can I calculate the size and quantity of wire required to rewind this resistance to start against full load?—"ASTATIC."

QUESTION NO. 110.

How are water wheel generators got into exact step? With a steam turbine, a small hand or motor operated wheel will give a small amount of regulation of speed. Is a similar method adopted with water wheel generators?—"PHASE."

(Replies to Questions Nos. 109 and 110 must be received not later than January 29, 1921.)

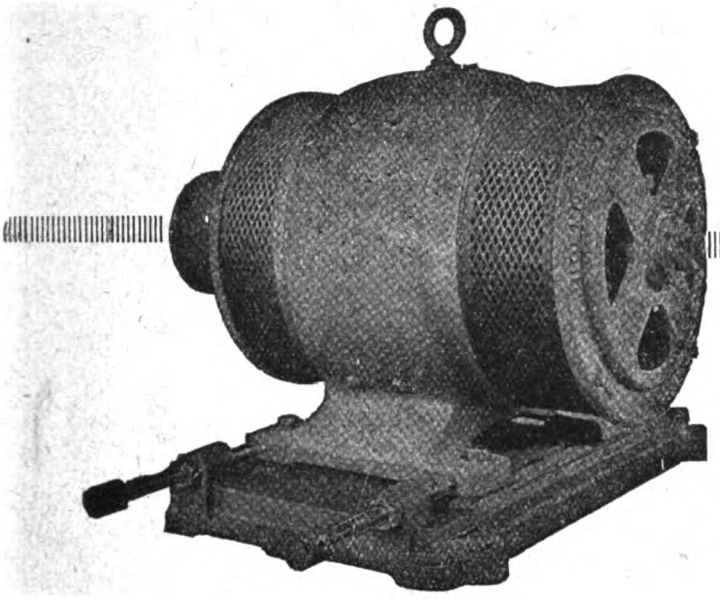
D.C. MOTORS FOR VARIABLE VOLTAGE.

In certain cases, for instance, in submarines, it is required that direct current motors should be supplied from a battery of accumulators, the voltage of which is liable to vary between 1.65 and 2.7 volts per cell.

Notwithstanding this voltage variation, it is possible to construct motors that run at practically constant speed. In the case of submarines, the voltage may vary between 220 and 330 volts, and 100 h.p. motors have been built that run at a speed that varies by only about 1 per cent. within these voltage limits, this result being attained by providing series, shunt and commutating pole windings, and also back ampere-turns on the field. The relative magnitudes required for the ampere-turns required on these various windings are discussed at some length. (Abstract in the *Technical Review*, of an article by H. Roth, in the *E.T.Z.*)

Blackpool.—Sanction has been received to the following borrowings: Buildings, £600 for 30 years; £26,426 for 25 years; and transformers, etc., £2,974 for 20 years. The Electricity Committee have accepted the tenders of Park Royal Engineering Works for three switches for H.T. gear for transformer chambers and the tender of Metropolitan-Vickers for a H.T. switch. The cost is to be charged against the new £30,000 cable loan.

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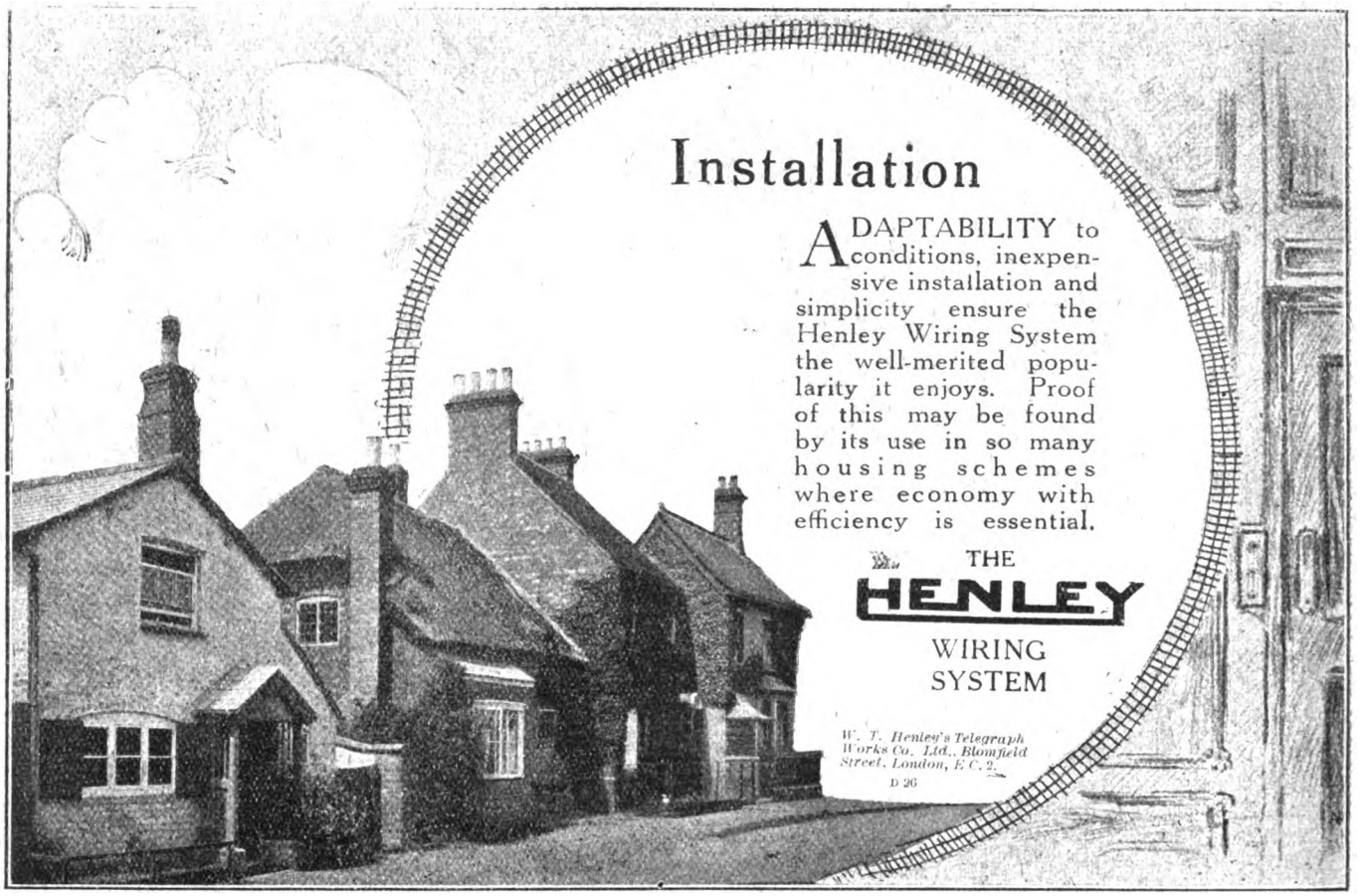
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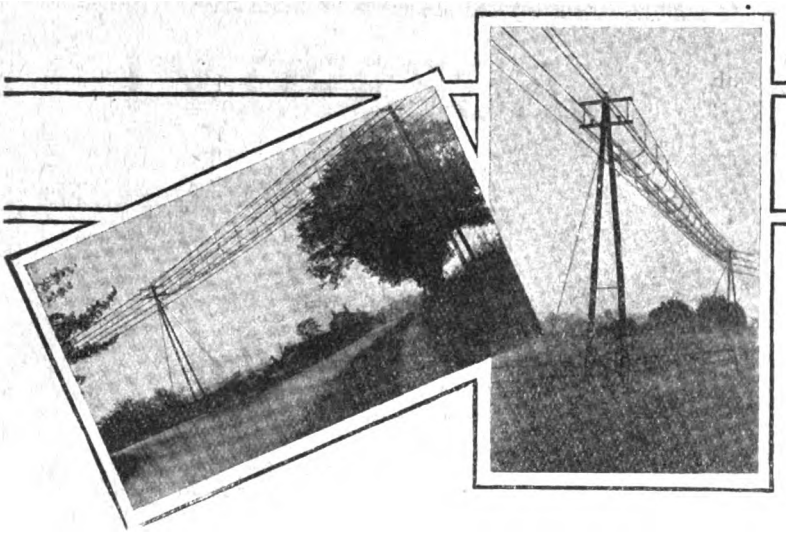
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1920 Engineering on A.D. 20 Foundations.

OUR illustrations show two Cradle Spans in a 6,600-volt 3-phase Power-Carrying Line installed by us to the order of the Appleby Iron Co., Ltd., Scunthorpe.

The picture on the right shows the Line crossing a sunken road, the pole on the far side being an angle pole fitted with double insulators.

The picture on the left portrays the Line crossing Ermine Street, the far-famed Roman road which is still for long distances a living highway, its solid Roman foundations having survived the Dark Ages. The pole on the left of the picture is fitted with duplicate suspension and earth guards, the Line from thence running alongside the public thoroughfare.

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ELECTRICAL ENGINEERS & CABLE MAKERS

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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 96 39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Cheaper Wiring Systems.

One of the most crying needs of the day if electricity supply is to be brought within the reach of small householders is a cheaper system of wiring than the orthodox and undoubtedly excellent conduit. There are alternative systems on the market, *vide* Henley's Stannos, etc., but there is still a link missing for the smaller cottage property. Mr. Milne in his paper before the Institution last autumn pointed out the great advantages which would accrue from the introduction and official approval of such a system or systems, and the subject was later commented upon by the *Faraday Journal* which instanced the absurdities of contrasting the relative safety of premises lighted respectively by paraffin lamps and electricity installed on the conduit system. Yet no exception is taken to the use of types of paraffin lamp which are potential sources of conflagration every time they are used.

Most electricity supply regulations are very drastic in regard to protection against fire risks, and rightly so, but there has grown out of this insistence upon safety a theory that for electric wiring something in the nature of solid drawn steel tube with numerous draw-in and inspection boxes is an absolute *sine qua non*. A certain infinitesimal fire risk must be allowed, or it is manifestly unfair to allow householders the free use of unprotected candles. In these matters we are woefully inconsistent. Some electrical contractors, if asked to install such a dangerous appliance as a paraffin lamp would insist that at least it must be firmly secured to the floor or wall, that it should be fitted with a fire extinguisher in case the paraffin container explode, and that it should be impossible to turn the wick either too high or conversely so low as to immerse the charred tip in the paraffin.

Then as to outdoor service connections; isn't it rather extraordinary that overhead wires have not caught on more in this country? Such services would be quite unobtrusively contrived at the backs of consumers' premises and need not be a danger to passers-by. The universal application of the metal filament and gas-filled lamp has reduced current consumption for lighting at all events to such dimensions that very small conductors will serve quite a large installation, and it is no longer necessary or desirable to run heavy conductors from street service mains to the householder's meter. Possibly the slow development of this cheap method of distribution may be due to public ignorance of its possibilities, a fact which a recent incident at Hayward's Heath would appear to indicate.

It seems that a member of the Urban Council at Hayward's Heath had electric light installed at his residence, and in connection therewith wires were erected across the highway. The Council has hitherto vetoed overhead wires of this character, but on looking up the legal position suddenly discovered that so long as poles are erected on private ground and the wires do not interfere with traffic on the highway there is no necessity to obtain the Council's permission. If on the other hand, the poles themselves are erected along the highway, the legal position is different.

There is a good deal of private electric lighting installed at Hayward's Heath, but this is the first instance of the generating plant of one house supplying another, the germ, perhaps, as a local paper points out, of a system of lighting for part of the township. Burgess Hill has been electrically lighted for some years now, and the same system was there adopted, viz., overhead wires on poles erected on private property. At the Hayward's Heath Council meeting at which the matter was ventilated, it was decided to refer the subject back for further consideration. Incidentally, the episode points the way to considerable expansion in the electrification of house property. When I stayed in Wales last Easter the service wires for the electric lighting of the hotel came in from a pole line just under my bedroom window, and were by no means unsightly.

No Money.

By a curious coincidence I had no sooner written my last week's notes on the financial stringency and the possibility of the adoption of the old-time system of barter, or the exchange of goods to value, than I read of the system being actually applied to the disposal of herrings. Early in December the Government announced that no herring price would be guaranteed in 1921. The news took the fishermen by surprise, and as a result of conversations among the fisherfolk in Scotland some system of barter is suggested as a way out of the difficulty created by the removal of control. A minimum price per cran (750 fish) has been suggested, together with its disposal among the fishermen and a sinking fund respectively. Buyers would also be expected to contribute to the latter.

Salesmen's commissions to be a fixed percentage below that of 1920, and the difference also to go towards swelling the sinking fund, as well as discounts on buyers' accounts. Government to facilitate bank advances to buyers for the payment of fishermen. A committee to endeavour to arrange some system of barter whereby goods would be imported into the fishing villages, of equivalent value to the amount of herrings exported. Government also to allow the bartered goods to be imported free of levy. Such, in brief, and according to a *Daily Mail* contributor, is the solution now being discussed by Scottish fisherfolk. With its mind set on economy the country is sick of doles and subsidies, and a scheme of bartering herrings on some such lines as the foregoing would not cost the taxpayer a single penny. On the other hand, it would have the effect of restoring much-needed confi-

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dence to an industry manned by men to whom the country owes much for the keeping of the seas during the war.

Motor-Buses and How Not to Run Them.

Some months ago I congratulated the Liverpool Corporation upon its acquisition of a motor-bus service and referred to the enterprise shown by the Merseyside Corporation in being among the first of municipalities outside London to recognise the limitations of the electric tramway for busy cities. Liverpool has tried its experiment and failed lamentably. It is not the fault of the motor-bus as a means of passenger transport that the city claims to be losing £40,000 annually on the venture, and has already curtailed the service. It would be interesting if the motor-bus accounts could be made public. In the first place, a type of vehicle was adopted which it was very obvious to any observant engineer could not fail to have a rapidly deteriorating effect upon ordinary road surfaces. Apparently no assistance or advice was sought from other authorities with experience of motor-omnibus services, either in the choice of suitable vehicles or the general questions of organisation, management and maintenance.

Although the engines of these 'buses were made by the same company which caters for the requirements of the London General Omnibus Company, there were more breakdowns in Liverpool in the first three to six months' running than one witnesses in a corresponding period of years in London streets. The vehicles were more often out of commission than in; it was impossible to rely upon the service because there were apparently no spare buses to take the place of the stranded ones. Sheds were at first located miles away from the route so that the empty vehicles had to eat up gallon upon gallon of fuel to travel to and from their service routes. Depreciation of road surfaces set in very early, and, as a result, the original routes, which alternated with those already served by the trams, were changed so that the 'buses would run over paved setts, and serve the same routes as the trams, an obviously suicidal policy seeing that their only advantage then was in the matter of a somewhat speedier journey. No wonder the service runs at a loss, and small wonder that a local heavy motor concern has offered to put the system on a paying basis on the principle of no cure no pay.

ELEKTRON.

Ediswan Social.—On the 5th inst., the second of a series of Socials was held in the Bristol Showrooms of the Edison Swan Electric Co., Ltd., under the Chairmanship of Mr. Fifield. A varied programme of songs, dialogues, recitations and a display of conjuring made the evening a complete success.

Meetings.—The next regular meeting of the Kelvin Lodge will be held at Mark Masons' Hall, Great Queen Street, London, W.C.2, on Friday, 28th inst., at 4 p.m.——The Inst. E.E., will meet at the Inst. C.E., Great George Street, Westminster, S.W., on Thursday, the 27th inst., at 6 p.m. Paper: "Temperature Limits of Large Alternators," by Mr. G. A. Juhlin (Member.)—— The Junior Inst. of Engineers, will meet on Friday, 21st inst., at Caxton Hall, at 8 p.m. Lecturette: "Motor Yachts," by Basil H. Joy. Also on Friday, 28th inst., at Institution Rooms at 8 p.m., Lecturette: "Manufacture of Portland Cement," by J. W. Wardell (Member), and on Friday, 4th February, at Caxton Hall, at 8 p.m., Lecturette: "Surface Tensions and Some of its Industrial Applications," by W. H. Ballantyne, B.Sc., Member).

ELECTRICAL ENGINEERING, GRADE II.
C.C. WORK.
Solutions to Questions set at the 1920 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page 23.*)

Q. 10.—A transformer is connected to a source of supply whose frequency and potential difference can be independently varied. Explain carefully how the core loss will vary if (*a*) the frequency is kept constant and the voltage varied, and (*b*) the voltage is kept constant and the frequency varied.

A. 10.—The core loss of a transformer consists of (*a*) the hysteresis loss due to the iron being subjected to alternating magnetisation, and may be regarded as the energy required to overcome the friction within the iron owing to the molecular magnets being continually reversed; and (*b*) the eddy current loss due to the circulating currents that are induced in the laminations by the alternating flux.

The hysteresis loss is proportional to the frequency of the alternating current and to the 1.6th power of the flux, whilst the eddy current loss is proportional to the square of the frequency and the square of the flux; *i.e.*, if f be the frequency, and ϕ the flux, then

$$\text{hysteresis loss} = k_1 f \phi^{1.6}$$
$$\text{and eddy current loss} = k_2 f^2 \phi^2,$$

where k_1 and k_2 are constants for a given transformer.

If a sinusoidal voltage V be applied to a primary winding having T turns, and if the voltage drop due to resistance and magnetic leakage be negligible in comparison with the induced e.m.f., we have

$$V = 4.44\, T f \phi \times 10^{-8}.$$

Now, if the frequency be kept constant and the voltage varied, then $\phi \propto V$, so that

$$\text{hysteresis loss} \propto V^{1.6}$$
$$\text{and eddy current loss} \propto V^2,$$

i.e., the core loss varies approximately as the square of the voltage.

On the other hand, if the frequency be varied while the voltage is kept constant, then $\phi \propto \frac{1}{f}$, so that

$$\text{hysteresis loss} \propto f \times \left(\frac{1}{f}\right)^{1.6}$$
$$\propto \left(\frac{1}{f}\right)^{0.6}$$

$$\text{and eddy current loss} \propto f^2 \times \frac{1}{f^2}$$
$$= \text{constant},$$

i.e., the eddy current loss is now independent of the frequency. Hence the core loss decreases to some extent as the frequency is increased, the decrease being small or large according as the hysteresis loss is small or large in comparison with the eddy current loss.

(*To be continued.*)

Burnley.—At a meeting of the T.C., when the unemployment problem was considered, Mr. Sutcliffe said they had work in the Electricity Department which would provide full time employment for about 400 men if they could get a sufficient number of cable jointers. Nearly 300 people wanted electricity in their houses, but they had not men to carry out the work.

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JUNCTION BOXES.

Amongst the various difficulties against which electric supply engineers have had to contend during the last few years has been the slow production of junction boxes. Bad as the position was for obtaining deliveries during the war, the supply undertaking could feel that it had other reasons as well, backed by the approval of the Government and public, for the exercise of deliberation and selection in extensions of their networks and the connecting up of new consumers. Since the Armistice, hundreds of new consumers have been clamouring for connection; but the supply of straight-through and terminal boxes for the new mains, and service boxes and house-service cut-outs for new consumers lagged months behind the demand. Arrears accumulated during the moulders' strike, and now, although foundries are gradually making up for lost time, and cable deliveries are also appreciably better, the demand for junction boxes is likely to show little sign of abatement.

In these circumstances, it is not surprising that the Edison Swan Electric Co., Ltd., whose cable department has developed as rapidly in the output of main cables as in the supply of cables for house-wiring, should have decided to commence the manufacture of junction boxes at the Ponders End Works.

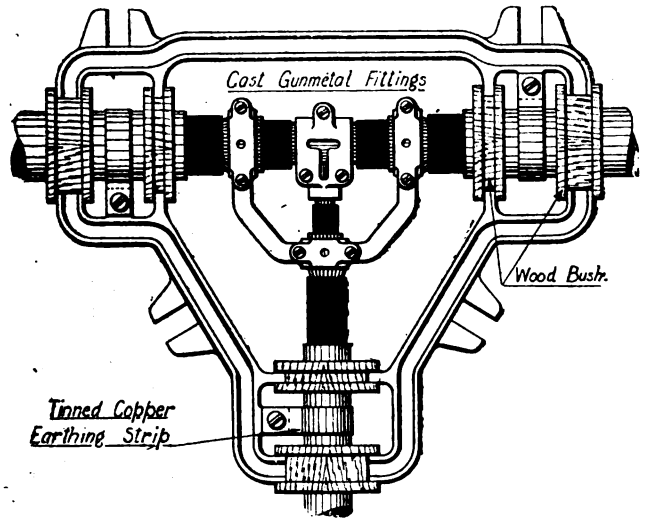


FIG. 2.—HOUSE SERVICE BOX FOR TRIPLE CONCENTRIC (MIDDLE AND NEUTRAL) OR CONCENTRIC CABLE.

The boxes, while following the lines which have been found most suitable for normal conditions in general practice, possess some interesting features in technical detail. Fig. 1 illustrates the three-core service box, a feature of which is that while there is ample room for making connections, and good clearance between the conductors themselves and the wall of the box, the amount of compound required for filling is reduced to a minimum. This point will be particularly appreciated by engineers in charge of large networks, on which the expenditure on box compound is a serious item. It will be seen by the illustrations that the compound gland type has been adopted, and that any uncertainty of proper bonding between the lead of the cable and the box is eliminated by a tinned copper earthing strip at each way, which is sweated to the cable and screwed down against a machined surface on the box itself. Another point, which will meet with the approval of the practical mains engineer, is the thickness of the lugs. Many engineers know to their cost the trouble from breakages of lugs in the earlier designs of junction boxes.

Fig. 2 shows the design of one of the service boxes for use on triple concentric distributors, the one for taking a service from the middle concentric conductor and the neutral without exposing the middle conductor, and it will be found a convenience that the castings of these boxes are made to

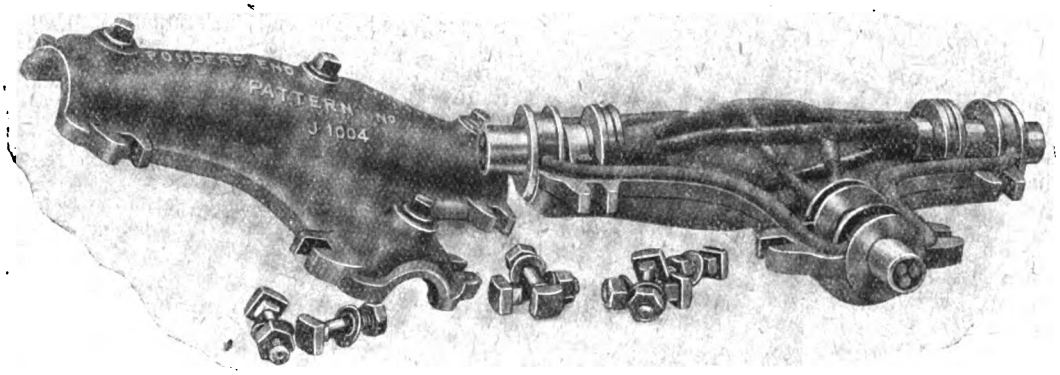


FIG. 1.—HOUSE SERVICE BOX FOR 3-CORE CABLE.

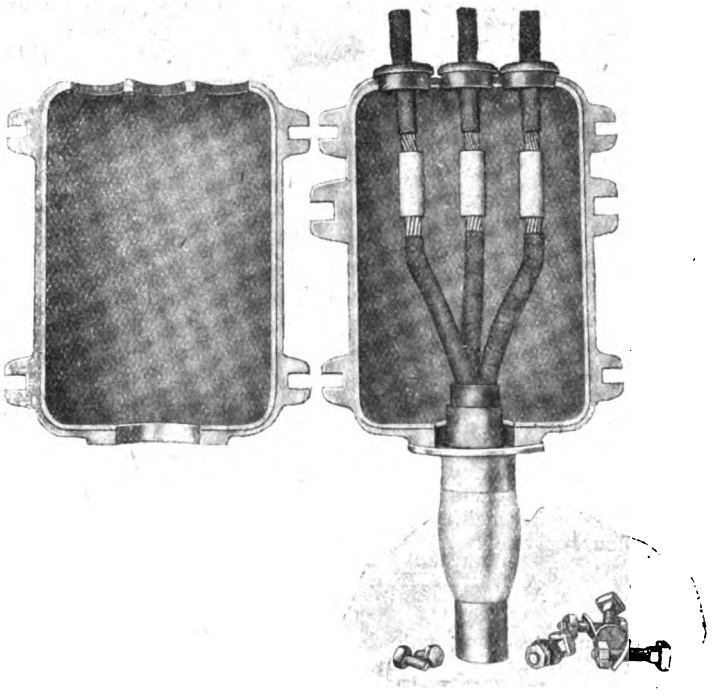


FIG. 3.—TERMINAL BOX FOR 3-CORE CABLE.

be interchangeable with those for use on ordinary two-conductor concentric cables. The boxes for services from the inner and neutral conductors of a triple concentric are, of course, larger, as the middle concentric conductor has to be cut in order to bare the inner, and sufficient length has to be provided for the fitting to re-connect it.

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In the terminal boxes (Figs. 3 and 4), the Ediswan Co. has adopted the wiping gland in preference to the compound gland. The former, although it may involve the exercise of a little more skill in fitting up the box, always presents a neater appearance, ensures good bonding, and eliminates the drippiness and stickiness which are frequently in evidence when a compound gland is used in a vertical position. In its terminal box, the Company has departed from the usual practice of screwing the wiping gland into a thread cut in the two halves of the box. With a screwed-in wiping gland, it is virtually impossible to have a perfect joint both between the two halves of the box from top to bottom and between the gland and the box. If one is sufficiently tight, the other is apt to be too loose. In the Ediswan pattern the brass wiping gland has wide flange which is bolted to a machined surface on the lower end of the box. Besides ensuring a good bond, the two halves of the box can be bolted tight together and the compound poured in at a high temperature without risk of its leaking. Separate bushes are provided for each of the tails, which have a straight vertical run making short-circuiting absolutely impossible.

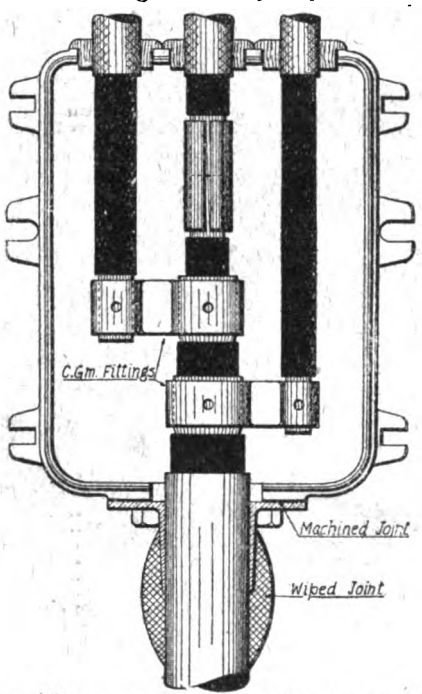


FIG. 4.—TERMINAL BOX FOR CONCENTRIC CABLE.

The Ediswan Co. has issued an illustrated catalogue of low tension boxes, in which these and other patterns are described in detail. A feature being a list of a dozen sizes of plain castiron cases with iron covers, with a list of extras for tapped bosses for conduits, wiping glands, sealing glands, packing glands, and filling plugs to make them adaptable to any purpose for which special boxes are required.

Together with the above list, a separate catalogue of house-service cut-outs has also been brought out.

ALUMINIUM TRANSMISSION LINES.

An interesting note has appeared in the *Technical Review*, prepared from an article by M. Dusaugly, in *Annales des Postes, Télégraphes et Téléphones*, describing the manufacture, qualities, and use of aluminium for electric transmission lines.

A Commission on Aluminium, appointed in 1913 decided that the following rules should hold for commercial aluminium :—(1) It should be 99 per cent. pure. (2) For wires in suspension, the breaking stress should exceed 20 kg./mm.^{2} for wires up to 35/10, and should exceed 18 kg./mm.^{2} for wires 35/10 to 50/10. The tolerance on strand diameter is 2 per cent.; the tolerance on stress is 2.5 per cent. For aluminium used in machines and insulated cables the breaking stress should not exceed 9 kg./mm.^{2} (3) The limit of elasticity for hard-drawn wire shall not be less than 11 kg./mm.^{2} The extension at rupture of hard-drawn wire shall be 2 per cent., and of annealed wire 25 per cent. (4) The pliability shall be tested by bending through 180 deg. backwards and forwards round diameters as follows :—

Diameter of the bend, 6 mm.—12 mm.
No. of bends=25 for a 1.0 mm. wire, 15 for a 3 mm.
No. of bends=20 for a 1.5 mm. wire, 12 for a 4 mm.
No. of bends=15 for a 2.0 mm. wire, 10 for a 5 mm.
No. of bends=10 for a 2.5 mm. wire.

(5) The resistance of annealed conductors shall be 2.89 michroms per cm.^{3} at 20° C., *i.e.*, 60 per cent. copper conductivity. Conductivity of hard-drawn wire shall be 2.95 michroms. The temperature coefficient is taken as 0.00449 per 1° C. Tolerance on resistance, 1 per cent.

A comparison of the merits of metal using copper or aluminium shows that the relative weight of aluminum to copper is 30 to 100 for equal section, 42 to 100 for equal heating by the same current, 52 to 100 for section of equal conductivity. If the price of aluminum is m times that of copper (pre-war, $m=1.5$), the saving in using aluminium becomes in these cases, $100-30\,m$, $100-42\,m$, $100-50\,m$, or 55 per cent., 37 per cent., 25 per cent.

The increase of resistance due to high frequency currents is less in aluminium than in copper. The relative sags on a 60-metre span of 3 mm. wire at 10° C. are, 150 cm. for aluminium and 47 cm for copper; the wires having been erected to give a factor of safety of 3, when the wind pressure is 120 kg./metre^2, equivalent to a pressure of 72 kg. per sq. metre of longitudinal section of wire. Other comparisons at various temperatures are given. Instead of using bronze, duralumin might be used. The author knows of only one aluminium-steel transmission line in Europe, namely, in the Dauphine, where a 60,000-volt transmission line at an altitude of 6,000 ft., made of 6 conductors, 3 being 112 mm.^{2} section (breaking stress 2,900 kg.), 3 being 88 mm.^{2} section (breaking stress 2,270 kg.), has lasted for two years with only two breakdowns; one due to the slipping of a support, the other due to an electrical contact with a low-tension line. The conductors were designed to carry 9 kg. of ice per metre. The use of aluminium-steel lines with spans of 300 metres is suggested and a table of comparisons for such lines is given.

THE ROYAL EDISWAN "FULLOLITE" LAMPS.

One of the principal objections to the use of the ordinary type of gasfilled lamp without scientificially designed shades for shop window lighting, etc., as well as for office and domestic lighting when methods other than the indirect system are used, is the glare effect of the intensely brilliant filament.

The "Fullolite" lamp which has recently been introduced by the Edison Swan Electric Co., Ltd., overcomes this objection by the provision of an opal glass bulb instead of the usual clear glass. The surface of the opal glass being smooth and polished, the bulb does not collect dust, in the same way that the ordinary sandblasted or acid obscured lamp, with its roughened surface will do. The new lamps can be obtained in all standard voltages and ratings up to 200 watts.



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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

THE ELECTRIC LAMP INDUSTRY. By G. A. Percival. (Pitman. 112 pp., 27 figs. 3s. net.)—With the collaboration of English and American contributors the author has contrived to produce a most readable book on an industry but little understood, except by those actively engaged in it, and not at all understood by the majority of users of electric lamps. It may be said at the outset that the information is thoroughly up-to-date and, by carefully restricting references to the details of manufacturing operations, both as regards processes, and the design and use of automatic and semi-automatic machinery, the essential features in design and manufacture of carbon filament lamps and of tungsten filament lamps of the vacuum and gas-filled types in all sizes are clearly set forth within the compass of some 74 pages. The remaining 32 pp. of text are devoted to a more brief account of arc lamps and vapour lamps, both of which, even at the present stage have considerable uses. The treatment of the more important part of the subject differs from that more commonly given hitherto in that the real value of the various patents is now appreciated and unnecessarily long references to them are entirely avoided. The information concerning glass manipulation and pumping equipment in Chapter I. is both interesting and valuable. Even among those who have some knowledge of lamp manufacture there are many who will be enabled by a study of Chapter III. to appreciate the uses of "getters" or "fillers" as well as the different arrangements of filaments, which are adopted in practice, British Patent No. 11544/15 being referred to. Users of gas-filled lamps will better be enabled to tell a good lamp from a bad one after reading Chapter IV., which also is full of good information for those in search of general knowledge of this very important unit. Finally, it should be mentioned that a short space is found for the Ediswan "Pointolite" lamp, which will probably be developed so as to be of general commercial use. The only fault to be found is a small one, and one which unfortunately has occurred in many books published during and since the war—it is that of "printers' errors," or more correctly, hurried proof checking. In this case the errors are not numerous but "connection" instead of "convection," "Hernst" instead of "Nernst," etc., are confusing to anyone not familiar with the subject. A small book on the electric lamp industry was badly wanted and now that a good one is available it should be widely read.

THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM. By J. H. Jeans. 627 pages, 138 figs. (Cambridge University Press. 24s. net.)—This is the fourth edition of the standard treatise by Professor Jeans, the first edition of which appeared in 1908. The work is so well known to students of physics that it is unnecessary to indicate here more than briefly its contents. The book is divided into four sections. In the first section, electrostatics and current electricity are grouped, and together the treatment of these two divisions of the subject occupies more than half the book. Two features of this section are a full and lucid account of potential-theory, and the development of generalised methods of determining current values in networks of conductors. The second section is shorter than the first; albeit it deals adequately with permanent and induced magnetism, including terrestrial magnetism. The third section is devoted to electro-magnetism, and it is to this section that the more important alterations have been made in the present edition. In it, electro-magnetic phenomena receive exhaustive treatment, but the portions that will probably attract the attention of most readers are those dealing with alternating and induced currents, including the theory of transformers, and the propagaation of electro-magnetic waves in space. The fourth section is wholly new, and is devoted to the theory of relativity. This section should serve as a good introduction to readers who intend to proceed further with this difficult subject.

The language is clear and direct, and the treatment and arrangement are excellent. This volume will probably be deemed by many as ranking among the best connected treatises in the English language on the mathematical theory of electricity and magnetism that have appeared since Clerk Maxwell's great work on the subject saw the light in 1871. It is printed and bound in a style befitting the high reputation of the Cambridge University Press, and it can be strongly recommended to all earnest students of physics.

Various Items.

Brazilian Railway Electrification.—The Central of Brazil Rly., which is owned and operated by the Brazilian Government, is to be electrified.

Company Registrations in 1920.—A report issued by Jordan & Sons, Ltd., Company Registration Agents, of 116-17, Chancery Lane, W.C.2, shows a greater number of company registrations in 1920 than in any previous year, including 1919.

Change of Address.—Messrs. Wallis-Jones & Dent, Consulting Engineers (Mr. Reginald J. Wallis-Jones, M.Inst.C.E., M.I.E.E.), have removed to their new office at Adams House, 23, Old Queen Street, Westminster, London, S.W.1. Tel. Victoria 8070. Telegrams, Alteration, Vic., London.

Manufacturers' Samples at Rotterdam.—A small sample room is now available at Rotterdam. U.K. firms wishing to have samples of their manufactures exhibited should forward same direct to His Majesty's Consul-General at Rotterdam, at the same time advising the Department of Overseas Trade of any action so taken.

Ebbw Vale.—The main ring, or transmission line in course of being installed by the Ebbw Vale Steel, Iron and Coal Co., is being rapidly fixed in position. It is for the purpose of linking up all the Ebbw Vale and associated collieries and the outlying works. The plant is now producing at the rate of 40,000,000 B.O.T. units per annum.

Exhibitions in 1921.—The Second Netherlands East Indies Fair is to be held at Bandoeng (Java) from September 19th to October 9th of this year. The Fair will be international in character and will offer manufacturers an opportunity of exhibiting wares of all kinds to a vast number of potential buyers in the East. A booklet setting forth all details, in English, is being prepared by the British Chamber of Commerce for the Netherlands East Indies, at 38, Dover Street, London, W.1.

More Wage Reductions.—The American Woollen Company (says a Reuter wire) announces a wage reduction of 22½ per cent., giving as reason for this step general business conditions. Mr. Wood, the president of the company, in a statement to the employees, said that if the prevailing rate of wages could be maintained, he would have been only too glad, but the attitude of the public was against this. "They will not pay the prices present wages involve," he said, "and we must all bow to the public will." To this the employees agreed, on the principle that it is better to have work and wages than no work and no wages.

Inst. E.E. Associate Membership Examination.—It is proposed, if a sufficient number of candidates make application, to hold in London, in April, 1921, an examination for Associate Membership. Arrangements will also be made for the examination to be held at Local Centres in the United Kingdom and abroad. Applicants desiring to sit for the examination should send their entry forms and Examination Fees in time to reach the Secretary of the Institution, 1, Albemarle Street, London, W.1, not later than the 1st March, 1921. Entry Forms and copies of the Examination Regulations may be obtained on application to the Secretary.

Smoking Concert.—Although the programme supplied for the Electro-Harmonic Smoker on the 14th inst., was in every respect first-class, we think that the recent spell of inclement weather must have prevented quite a number of members from attendance, because the hall was not quite so crowded as it has been on previous occasions. Mr. W. M. Lackie made an excellent Chairman, and the items contributed by Mr. Warwick Price, Mr. Dan Jones, Mr. Will Edwards and other artistes were

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received with every expression of approval. The next Concert due on February 11th, will be a ladies' night, and the programme will be announced in due course.

Meetings.—The following is the programme for the first half of the 1921 session of the Birmingham and District Electric Club. Namely: Saturday, Feb. 12.—Paper: "Reminiscences of the Test Bed," by Mr. C. J. A. McDonald (Member); Saturday, Mar. 12.—Paper: "Common Sense Methods of Recording Costing and Progress in Shop Management," by Mr. H. C. Young, A.M.I.E.E. (Member); Saturday, April 9.—Paper: "Supply of Electrical Energy in Birmingham and District," by Mr. Frank Forrest, A.M.I.E.E., Chief Asst. Elec. Engineer, Birmingham, Chairman Local Section I.E.E.; Friday, Mar. 4.—Social. Annual Dinner. All Meetings are held at the Headquarters, Grand Hotel, Colmore Row.

Burnley.—The town has several costly schemes in progress—at Hurstwood, the Electricity Works extensions, and numerous improvements requiring £300,000 to £400,000 in the next year or two. It is hoped to raise the money without seriously disturbing the present rate of interest. Recently the Electrical Engineer said that the present generating power was 5,250 kw. Additional plant was on order which would bring this to its maximum capacity, viz., 8,250 kw. He anticipated plant capable of generating an additional 8,000 to 10,000 kw. would be necessary to meet probable requirements during the ensuing five years. Land and buildings in Aqueduct Street are to be transferred to the Electricity Department.

Wanted, 10,000 Meters.—The State Power House in Monte Video invites tenders for the supply of 10,450 meters for the private installations served by it, the supply comprising a three-phase, 50-cycle system, with 200 volts between phases. The meters required are of the following types: (a) Single-phase meters with single tariff for range of 2.5 to 20 amperes. (b) Three-phase meters with single tariff for range of 5 to 75 amperes. Preference will be given to meters of the induction type. A copy of the specification, conditions of tender, and list of spares to be provided, in Spanish (also of a similar call for tenders for 500 D.C. meters for the provinces), can be seen in Room 48, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Harrogate.—An inquiry has been held here by Colonel T. C. Ekin into an application by the Corporation under the Electricity (Supply) Acts 1882 and 1919 to borrow £22,000 for the electricity undertaking. Mr. G. Wilkinson, borough electrical engineer, said that the estimated maximum demand by the end of the year would be 1,870 kw., by next year 2,200 kw., and 2,500 kw., in 1922. They had been fortunate in not having a breakdown with their existing plant, as their resources were so small. If the rural council area came to be supplied, they would still not have a full capacity, even with the extensions for which they were now asking. The Inspector pointed out that their boiler capacity was only sufficient to supply their present needs. With regard to charges, Mr. Wilkinson said they had risen only 50 per cent. over pre-war.

Electrical Pumping at Newport.—The electric pumps at the Alexandra Co.'s town dock which were recently installed at a cost of £12,000 are proving very satisfactory. There are two sets of three-throw single acting horizontal plunger pumps, each set being capable of delivering 300 gallons of water per minute at a pressure of 760 lbs. per sq. inch, when running at about 60 revolutions per minute of crankshaft, and supplied with the necessary direct current at 460 volts. The crankshaft is driven from the motor through one pair of machine cut, double helical spur gearing, the pinion being carried on a pin-coupled extension of the motor shaft with pedestal bearings. The motors are the Phœnix Dynamo Manufacturing Co.'s (now the English Electric Co.) enclosed ventilated compound wound D.C. motors, each capable of developing the necessary power when running at about 480 revolutions per minute on a 460 volt current.

Blackburn.—The completion of the super-power station will open up a new industrial era for this locality. The new station, which is bounded on one side by the canal and on the other by the railway, is rapidly reaching the finishing stage, and will cost some £850,000. The plant will be more extensive than originally proposed owing to the co-operation of neighbouring authorities and the general demand for the utilisation of power for industrial purposes. It is no secret that a number of cotton mills desire to install plant, and new undertakings are awaiting the provision of more power before embarking on their plans. At present, Blackburn station is over-loaded, and the new service will provide necessary relief, not only in Blackburn, but in Harwood, Rishtom, Darwen, etc. This will be the first station to be completed under the National scheme. The Council are applying to the Electricity Commissioners for sanction to borrow £600,000, being the difference between the amount already sanctioned and the amount of the new estimate.

1921.—A small leaflet containing much sound advice has just been published by Industrial Publicity Service, Ltd. (4-7, Red Lion Court, Fleet Street, E.C.4), and has been posted to their clients and connections. It is pointed out that our most perilous peace years were 1919 and 1920, when we were, many of us, living in a fool's paradise, believing that the world's greatest war had made us fabulously rich, and entitled to slack and squabble to our heart's content. The year 1921 has already shown us clearly the true position. It comes as a stern challenge to a strong people never yet daunted or defeated, and for the creative engineer, business organiser, inventor, scientific investigator, and far-seeing statesman is a very welcome year of mighty opportunity.

Calendars.—The calendar of the Hart Accumulator Co., Ltd., of Stratford, is indeed a wonderfully bold piece of printing, and should prove useful in any and every accumulator room or central station. On the upper part are illustrations of the Company's various types of accumulators as well as a good view of a Central Station Battery, while the calendar figures printed underneath are so bold that they can practically be seen from one end of a Central Station to another. It should certainly be in the possession of every Central Station Engineer.——From the Super Heat Furnace Co., Ltd., of Bradford, comes a useful wall calendar of the daily tear-off type, headed by a diagram illustration showing the application of the Company's special super-heating furnace.——The monthly tear-off calendar issued by W. H. Sugden & Co., Electrical Engineers, of Wakering Road, Barking, has a charming illustration of the "Pool" of London at night, showing the Tower Bridge in the distance. It is a most effective piece of colour-work.——Another choice specimen of the colour printer's art is that issued by Messrs. Haslam & Stretton, Ltd., Engineer's Agents and Merchants, of Cardiff. The illustration represents "Peggy," with a quotation from the well-known poet James Russell Lowell. In this instance, "Peggy" is a genuine pastel print from an original photograph, and will be an ornament to any office or private house.——From Messrs. Mather Bros., Electrical Engineers, of 36, Farringdon Street, E.C.4, we have received a good bold monthly tear-off calendar, and it was also accompanied by a nice telephone number card which is likely to prove exceedingly handy for ordinary office use.——We understand from Messrs. Henley's Telegraph Works, Ltd., of Blomfield Street, London Wall, E.C.2, that they still have a number of refills suitable for use in the Calendar which they issued last year, and if any of their customers have retained their last year's calendar and would care for a refill, they will be pleased to send one on hearing from them. The refills are the same as those issued with this year's calendar, and the monthly cards contain alternate cards of general cable information which will probably be useful to Electrical Engineers and Contractors.

Trade Notes.

Messrs. H. W. Smith & Co., Ltd., cable makers, Lydbrook, Glos., have opened a Sales Office at Central House, Kingsway, London, W.C.2. Telephone: Regent 2368.

Owing to increased business and the necessity of carrying larger and more varied stocks, **Messrs. Donovan & Co.,** have had to take additional larger premises at 16, Cornwall St., which will be used for bulk stores of electrical accessories—Cable, Conduit, and "Safuse" Switch Gear. The Offices and Sales Dept. will remain as before at 47, Cornwall Street, Birmingham, where they will be pleased to see their friends.

"Gecko" motor car and motor cycle electric head lamps, side and tail lamps are fully described in pamphlet No. O 2378, issued by the **General Electric Co., Ltd.** (67, Queen Victoria St., E.C.4), together with a complete range of Osram (G.E.C.) electric lamps for automobile lighting. Included are headlamps, both vacuum and gas-filled, for British, French, etc., and American cars, and twin filament lamps for motor cycles. The latter are rated at 6-7 volts, either 2 and .25 amps. or 2 and .5 amps.

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FRIDAY, JANUARY 28, 1921.

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AN INTERESTING WOOLLEN MILL ELECTRIFICATION.

Messrs. Rouse Bros., Vale Mills, Oakworth, situated in an isolated and interesting part of the West Riding of Yorkshire, after having been driven for upwards of sixty years mechanically by water wheels, were last year converted to electrical driving.

The electrical equipment is unique, inasmuch as induction alternators are used to generate the current from power supplied by water turbines. The use of generators of this type does away with complicated synchronising switchgear and the skilled attention which it demands.

Originally the water power was used principally for driving two large water wheels, one 43 ft. diameter by 9 ft. wide and the other 42 ft. by 6 ft. wide, the former being seen in Fig. 1. In addition to these two large wheels there was a smaller one about 20 ft. diameter by 9 ft. wide. The water for driving the wheels comes from two different sources, one at a much higher level than the other. That from the higher level was first utilised for the smaller wheel and then passed to the lower level supply, the whole supply then being used for the large wheels.

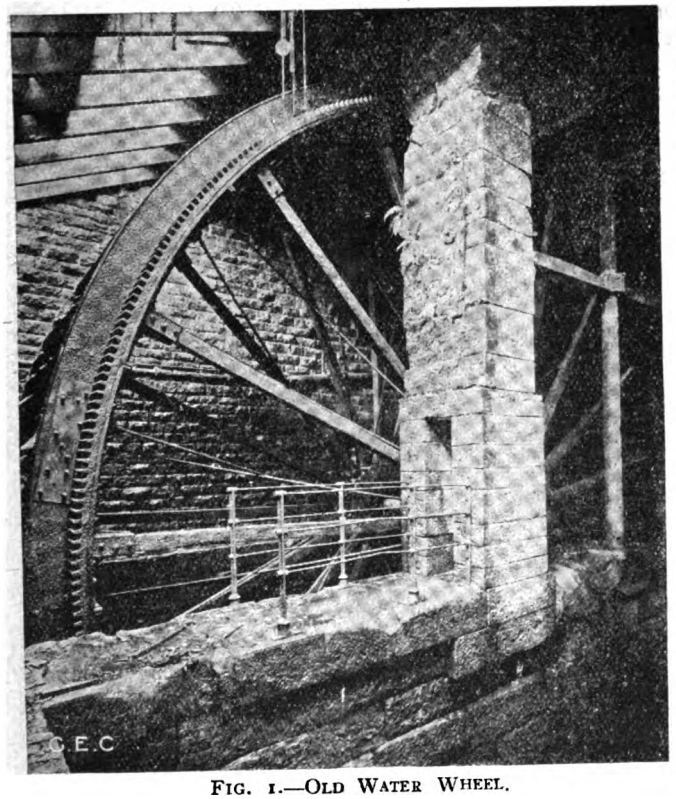


FIG. 1.—OLD WATER WHEEL.

The water, after leaving the wheels, passed away in an underground trailrace about a quarter of a mile long. The power from these wheels was transmitted in the usual way by heavy bevel gear and upright shafts, some of which were 8 in. to 10 in. in diameter, to different portions of the mill, a typical example being shown in Fig. 2. In addition to the water wheels, power was also obtained from a beam engine, which was capable of developing 600 h.p. It was connected to the main driving shaft by very heavy gears.

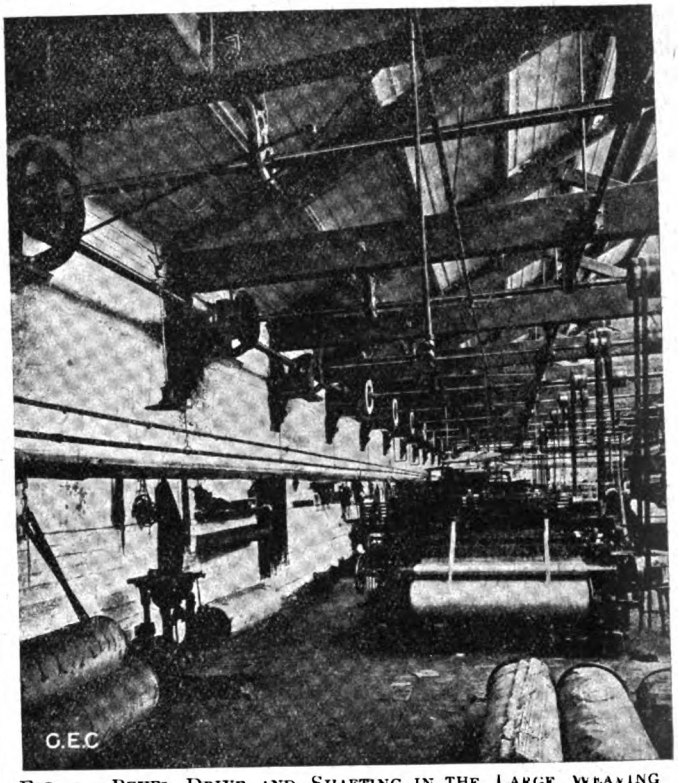


FIG. 2.—BEVEL DRIVE AND SHAFTING IN THE LARGE WEAVING SHED.

In order to improve the general efficiency, a decision was made to supplant the old water wheels by hydraulic turbo-alternators and to drive the whole of the machinery by electric motors. A reference to Fig. 1 gives a very clear idea of the state of the building containing the water wheel, and the fact that this interior was completely dried out and made suitable for electrical machinery is worth noting. The new turbine plant consists of three turbines, manufactured by Gilbert Gilkes, of Kendal, two taking water from the lower level supply and one from the higher. The lower level turbines are of the single discharge spiral casing type, and develop 125 and 64 h.p. respectively on a head of 36 ft. when using 2,300 and 1,200 cub. ft. of water per minute, the speed being 428 and 600 r.p.m. The turbines are carried on cast-iron combination bedplates and direct-coupled to the generators. The high fall turbine is of the double discharge twin runner type, and is arranged so that in periods of drought the water may be shut off from one runner, thereby enabling the other runner to be operated at a much higher efficiency than

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would be otherwise obtainable. This turbine is also mounted on a cast-iron bed and coupled direct to the generator. It is designed to develop 150 h.p. on a working head of 50 ft. when using 2,000 cub. ft. of water per minute and running at 600 r.p.m.

It is interesting to note that no governor gear is required, as the generators are run in parallel with the supply taken from the Keighley Corporation, and consequently the speed is maintained constant.

The simple manner in which these machines are put on circuit calls for special attention. First the distributor vanes on the turbine are opened to allow sufficient water to pass to run the turbine up to approximately synchronous speed; and secondly, the generator is switched direct on to the line, the vanes being opened fully out in order to allow the necessary amount of water to pass for the generator to develop its full output. This completes the operation.

Considerable difficulty was experienced in arranging the turbines in suitable positions without entailing excessive cost in altering masonry and pen troughs. This accounts for the peculiar angles at which the pipes run. Each turbine drives an induction type alternator, the outputs of which are 81 kw. and 43 kw. for the lower level turbines, and 103 kw. for the higher level machine. The electrical power taken from the mains of the Keighley Corporation is stepped down from 6,600 volts to 400 volts, by three 250 k.v.a. transformers, at which pressure it is distributed from the main switchboard which controls the alternators. It comprises three alternator, two transformer and four feeder panels. Each is equipped with oil switch, energy meter and so forth.

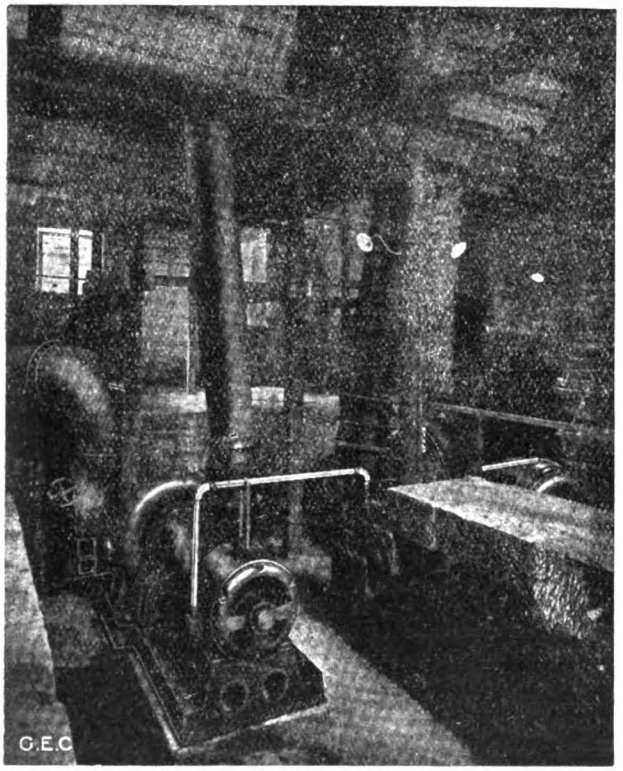


FIG. 3.—VIEW OF HYDRAULIC TURBO-ALTERNATORS.

The mill is divided into two main sections, the new and the old. In the former both spinning and weaving machinery is at work, the latter being devoted almost exclusively to spinning.

All the motors up to and including 60 h.p. are of the squirrel cage enclosed ventilated pattern running at 580 r.p.m.; above this size they are of the slip-ring pattern. All the 60 h.p., 80 h.p. and 100 h.p. machines are fitted with third bearing shaft extensions and are mounted on substantial cast-iron bed-plates.

The large weaving shed contains upwards of 100 looms driven by six 25 h.p. motors situated in the roof (two shafts each), while another shaft is driven by a 100 h.p. machine, the auto-transformer starters for these and the other motors in the mill being manufactured by Geo. Ellison, of Birmingham. The arrangement of driving the smaller weaving shed machinery (Fig. 4) is practically the same as in the larger shed, but only three 25 h.p. motors are required.

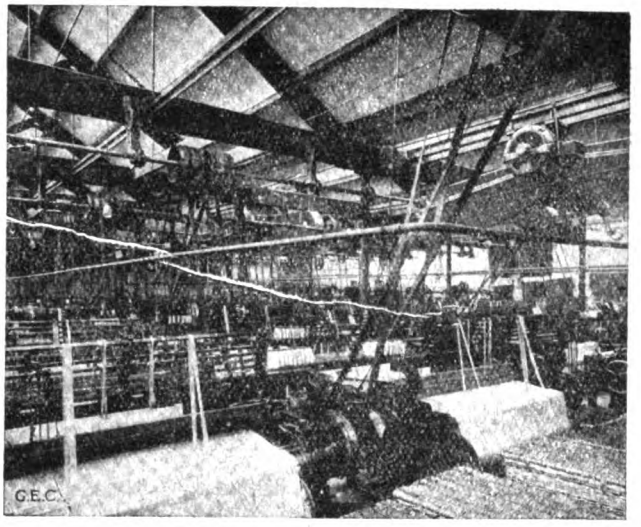


FIG. 4.—SMALL WEAVING SHED DRIVEN BY THREE 25-H.P. "WITTON" MOTORS.

In the new mill the electrical gear has for convenience in operation been grouped on the top and ground floors. The gear on the top floor consists of one 60 h.p. squirrel cage and one 80 h.p. slip-ring motor, together with their respective starting panels, each driving spinning frames through Hans Renolds chains. The 60 h.p. motor drives the top room, and the 80 h.p. motor the room below. On the ground floor is installed one 100 h.p. and one 80 h.p. slip-ring motor, the latter driving the ground floor through chain and the former the first floor by means of ropes (the centre distance being too great for chain driving in this case). Machines of the same power are interchangeable together with their chains, etc.

The contract for the electrification of this mill was carried out by the General Electric Co., Ltd., through their Leeds branch. In conclusion, our thanks are due to Messrs. Rouse Bros. for allowing publication of the particulars.

NORTH WALES AND CHESTER ELECTRICITY DISTRICT.

The Electricity Commissioners announce that they will hold a Local Inquiry at the Assembly Room, Town Hall, Llandudno, on February 15th, with reference to the area proposed to be included and to consider (a) a scheme which has been submitted by the North Wales Power and Traction Co., Ltd., for effecting an improvement of the existing organisation for the supply of electricity in the said district; and (b) a scheme which has been submitted by the Corporation of Chester for effecting an improvement of the existing organisation for the supply of electricity in the said district and for the formation of a Joint Electricity Authority. Copies of the respective schemes may be obtained (a) from the North Wales P. and T. Co., Ltd., Clark Street, Dolgarrog, North Wales, at a cost of 5s. each, and (b) from J. H. Dickson, Esq., Town Hall, Chester, at a cost of 3s. 6d. each.

Any body or person interested may attend the Inquiry either personally or by counsel, solicitor or agent.

Any representations or objections with regard to the said schemes or either of them should be addressed to the

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Secretary, Electricity Commission, Gwydyr House, Whitehall, London, S.W.1., not later than Tuesday, 8th Feb., and a copy of such representations or objections should at the same time be sent to the North Wales P. and T. Co., Ltd., or J. H. Dickson, Esq., as the case may be, at their addresses mentioned above.

"KANTARK."

We illustrate two items of electrical equipment manufactured by the Midland Electric Manufacturing Co., Ltd., Barford Street, Birmingham), of interest to installation engineers. Fig. 1 shows one of the Company's "Kantark"



FIG. 1.

cut-outs, which are of neat but strong design, particularly suitable for house service work. The contacts are shielded by the porcelain base and the arcing chamber is lined with

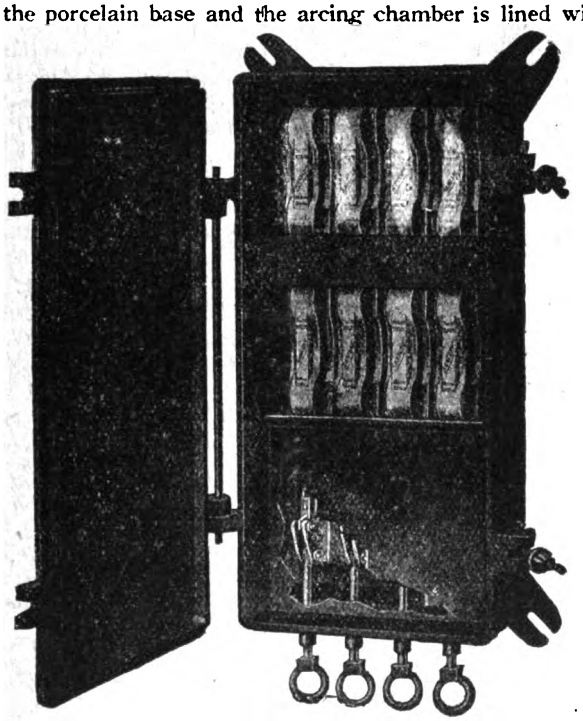


FIG. 2.

a special absorbent asbestos. Ventilation slots are provided so that explosion gases can get freely away, thus preventing damage to the fuse carrier. This can be readily re-wired and is designed to conform with the H.O. Regulations. Fig. 2 shows a "Kantark" distribution switch and fuseboard, designed especially for mills, yards, factories, etc., lighted by means of gas-filled lamps. It will be noticed that the single pole switches are operated by external handles and are protected by an insulating shield in conformity with the H.O. Regulations. The cut-outs are of the "Kantark" type as illustrated in Fig. 1. These boards are made for 250 volt circuits, 2 to 10 ways, 10 to 15 amps. each.

THE E.C.A. ANNUAL DINNER.

On Wednesday, the 19th inst., the members of the Electrical Contractors Association, the N.E.C.T.A., Ltd., and the National Federated Electrical Association assembled at the Connaught Rooms on the occasion of the annual dinner, when Mr. P. Collinson, the president of the joint associations, occupied the chair, and was supported by nearly 100 members and visitors who were entertained to some interesting speeches and an excellent musical programme. After the toast to "The King," Mr. Hugo Hirst proposed the success and prosperity of "The Allied Associations and Honorary Officials," and opened his remarks by a brief reference to the industrial outlook, which, he admitted, was at the present time somewhat gloomy, although he had hopes that it would improve in the near future. He referred to the way in which the great company with which he is so intimately associated had helped to build up the electrical contracting industry by refusing to carry out installation work and in its preparation of catalogues, which would be of direct value to electrical contractors. He produced an original G.E.C. catalogue issued in 1886, which was examined with interest by many of those present. In the course of his remarks he referred with regret to the complaint of a personal friend as to the way in which an electrical contractor had carried out certain installation work in which he had been given carte blanche to do the best he could for his client, and stated that he was interested in the efforts which were being made to improve the status of the electrical contractors as a body of men of reliable technical knowledge. Replies to the toast were given by Mr. Collinson, chairman, and Mr. Purchase, one of the leading members of the committee, after which Mr. H. J. Cash, the past president, proposed "The Guests," in which he included the Institution of Electrical Engineers and kindred associations, such as the C.M.A., I.M.E.A., E.D.A., and others, with whom, he remarked, that the relations of the E.C.A. were most harmonious. As president of the Institution, and also as representative of the C.M.A., Mr. L. B. Atkinson was the first to reply, and this he did in his usual straightforward and humorous manner; while Major H. Richardson, the president of the I.M.E.A. gave a clear and sound expression of the views of the association which he represented, and his hopes for the continuance of the mutual goodwill which was certain to be of such benefit to the industry, while at the same time he most cordially endorsed the necessity for paying the keenest possible attention to the subject of electrical heating and cooking, for which, he felt certain, there was enormous possibilities. Mr. W. R. Rawlings, in an appealing and, at the same time, humorous speech, proposed "Success to the Electrical Trades Benevolent Institution," to which Mr. J. Y. Fletcher (chairman of the E.T.B.I.) gave a suitable response, stating that he had very strong opinions on

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the subject, and that later in the year he was going to make a great effort to put it on a financial basis which would be more worthy of our great industry, a statement which was received with great applause from all present. The evening was concluded with the toast of "the Chairman," which was proposed by Mr. Cross and suitably responded to by Mr. Collinson. Musical items were rendered by Miss Winifred Bailey (soprano), Mr. Jack Rickards and Miss Violet Stevens (comedy duets), and Mr. A. Cannon (banjoist). Much credit is due to Mr. Leonard G. Tate, the energetic secretary of the three associations, for the very able way in which the whole of the function was organised, and for the hospitable manner in which he looked after the interests of all who were present during the evening.

POWER GAS.

Producer gas is obtained from anthracitic coal or gas coke by two processes; pressure producers and suction producers, and is now much employed in gas electric plants. In the former process a blast of steam and air is forced through a bed of hot fuel, while in suction producers a mixture of water-vapour and air is passed over the hot fuel at atmospheric pressure. After cooling the gas is purified in a scrubber. The composition varies, but it is chiefly a mixture of free hydrogen, carbon monoxide, and carbon dioxide, together with gases distilled from the fuel by the heat. Examples of producer gas are the Dowson gas and Mond gas, the names given from the mode of manufacture.

Water-gas, theoretically, should consist of equal volumes of carbon monoxide and hydrogen, and as both of these gases burn to carbon dioxide and water, it has a high calorific value. There are, however, about 7 per cent. of diluents and impurities present in it, so that only 93 per cent. are available for combustion. In making water-gas the fuel is raised to a high temperature by an air blast, the gases first formed—largely carbon dioxide and the diluent nitrogen—being allowed to escape. When this has been done the blast is discontinued and a current of steam is forced through the fuel, when carbon monoxide and hydrogen are formed, according to this equation:—

$$H_2O + C = CO + H_2$$

The production of water-gas is more involved than this simple reaction would indicate, as the decomposition of the steam into its constituents of oxygen and hydrogen lowers the temperature of the fire to such an extent that chemical dissociation ceases, thus preventing the free oxygen from forming the monoxide of carbon. The process is therefore an intermittent one—by shutting off the steam and again putting the air blast in operation, the steam is again split up into its constituent elements. The process can, however, be made continuous by using an auxiliary generator.

Blast-furnace gases.—Waste gases from the iron furnace are now much utilised for power. It has been estimated that in a plant producing 100 tons of pig iron per day, 150,000 cubic feet of gas per ton of iron are formed, and both in England and abroad these waste gases are employed usefully. Allowing for wastage, it is reckoned that 2,500 horse-power are available for work in a plant of this size.

These gases have not a very high heating value—about 100 British thermal units per cubic foot—as nearly 60 per cent. is nitrogen. The combustible gases are carbon monoxide (nearly 30 per cent.) with a little free hydrogen, while carbon dioxide is present in small quantity. The most troublesome material to deal with is dust, being present to the extent of from 5 to 12 grains per cubic foot. By means of a centrifugal cleaning plant the solid impurities are removed, at any rate, until the amount is negligible, .01 grain per cubic foot. It is of the first importance that any dust be reduced to this small amount before entering the gas engine, otherwise it will collect on the inner cylinder surface and become ground between piston and cylinder. Another danger is that it collects in the combustion chamber or valves, and there burns from the heat of the explosion, causing pre-ignition.

Coke-oven gases.—When coke is raised to a high temperature, with a limited supply of air, oven-coke is formed, and the coke-oven gases produced, as a by-product, have a high calorific value—the proportion of carbon monoxide being higher than in blast-furnace gases. The temperature of these gases is very high, about 1,200° F., and is lowered to 80° F., while in the process of purification. Tar and ammonia are also removed, the latter being formed into sulphate of ammonia.

A large proportion of coke-oven gas is used for heating the oven, this is allowed to be about 70 per cent., the remainder representing about 3,000 cubic feet per ton of coal burnt in the oven. This, multiplied by its calorific value and again by 778, to obtain its equivalent in foot-pounds of work, gives a not inconsiderable amount when expressed in power-production.

THE ENGINEER'S PEN.

Electrical engineers will welcome the latest innovation in fountain pens. It is called the K&J Super Pen and hails from the house of Kenrick and Jefferson, Ltd., of organising fame.



HOW K&J TEST THE K&J SUPER PEN BY DROPPING IT ON TO A BLOCK OF WOOD.

The great feature of the K&J Super Pen is the remarkable strength of the nib, which is, apparently, damage proof; at any rate we tested it on the office floor in the same way as K&J test it—by dropping it nib first—without it affecting the nib in the slightest.

It has a delightfully responsive touch and seems to fairly glide along the paper; moreover it is first-class for carbon duplicating.

K&J tell us that a good many large business houses have supplied this pen to their staff with economical results, and this is not surprising, for it is, to say the least, unusual to find a pen which is at once a delight to use, trouble free and damage proof.

The price of the K&J Super Pen is 12s. 6d., and it can only be obtained from Kenrick and Jefferson, Ltd., West Bromwich, or from their show-rooms, which are to be found in most of our large towns.

Progress.—The Westminster Tool & Electric Company have now completed the equipment of their new Westool Works, Putney Bridge Road, and are manufacturing in all sizes the Mark 1 pattern of the Westool Electric Portable Drills. These drills are meeting with great favour, and the No. 2 size, which has just been completed, is giving exceptionally good results. Fitted with a No. 2 Morse Taper Socket, the tool weighs complete 42 lbs., and will drill a hole $\frac{7}{8}$ inch diameter in mild steel $3\frac{1}{4}$ in. deep in a minute. The Westool Mark 1 type drills are fitted throughout with Ball Bearings, and have an exceptionally short overall length, while giving an effective feed, nearly twice that of other electric drills.

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PAGES FROM OUR DESIGNER'S NOTEBOOK

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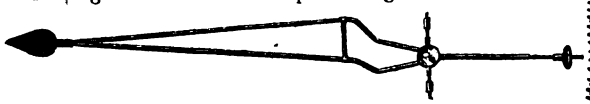
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The design of a system that shall have no resonant point within any commercial range of frequency, and yet be light and have a low moment of inertia, is a problem of no mean proportions, and, as a matter of fact, the first and only successful solution of this problem is embodied in the construction shown.

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The members of the trussed pointer are of aluminium of tubular section, and the walls of the tube do not exceed 1-1,000 in. in thickness. These members are riveted together, and the index tip which is exceedingly thin, is stiffened by a rib stamped in the metal, and following its contour. By this means thinner material may be used, and the weight is slightly lessened and the moment of inertia considerably reduced.

Accurate balancing of the movement is arranged for by the three arms, each of which carries a split sleeve nut tapped with 272 threads to the inch. Threads of this exceptional fineness are necessitated by the extremely small diameter of the pointer tail, which is made of a special aluminium alloy of great rigidity. In certain WESTON instruments, even finer threads are cut in aluminium, and owing to the impossibility of obtaining stock of the necessary degree of fineness the tubes are specially drawn in our own works.

Weston pointers other than the trussed type are built on the same lines as regards material, balancing arrangements, etc. The result is in all cases a pointer of minimum weight and maximum strength, unapproachable by any other design.

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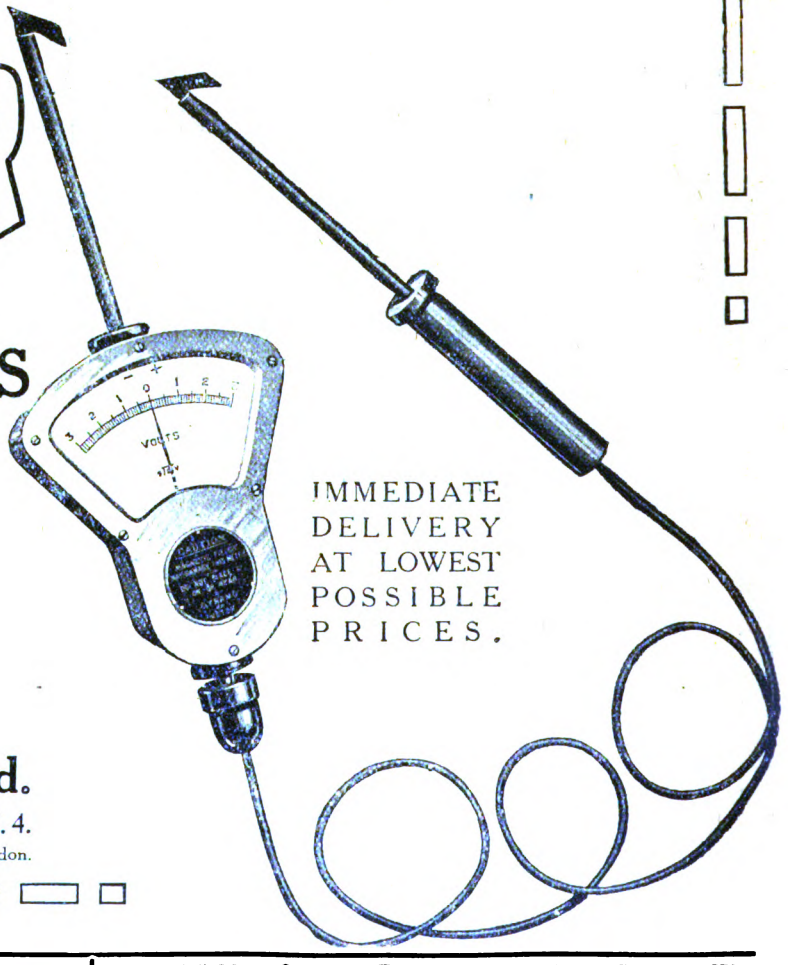
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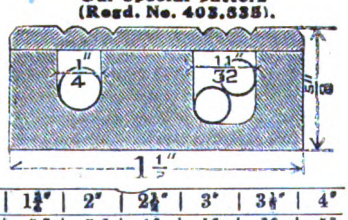
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ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

The Slump—

To the Socialistic labour agitators and Bolshevistic wreckers of industry, who, by their past tactics, have so largely contributed to the present industrial stagnation, I commend a study of Lord Weir's presidential address to the Junior Institution of Engineers, delivered just before Christmas. In the course of it he exposed certain fallacies and gave concrete figures illustrating the serious decline in our trade brought about by the absurdly inflated cost of production of all manufactured goods. Quoting from a Government paper, written just prior to the Armistice, Lord Weir directs attention to the following true prophecy: "In the future the greatest regret we will suffer from as a nation is that during the war we bargained for, trifled with, and complicated the conditions surrounding efficiency of production."

Speaking of exports, he showed how harmful had been the general impression created in the minds of the public by frequent references to the rising *values* of these exports as compared with pre-war *values*, thus entirely disregarding the fact that, to make good or overtake our pre-war standard of export trade, we have to send out of the country to foreign buyers from two to three times the total value reckoned on a pre-war basis. Quantity or tonnage is the only true factor in connection with export returns, and the misrepresentation of statements based on *values* is aptly indicated by diagrams which accompany Lord Weir's address, there being a fall in purely engineering exports as between 1913 and 1920 of 36 per cent. Per contra, in one item of imports, a deplorable state of affairs is revealed. The value of motor-cars, chassis and parts thereof imported in 1913 was approximately 7½ millions, as against nearly 23 millions in 1920. In other words, the British motor-car and associated industries lost the equivalent representative value of orders and productive work for wage earners, a fact which is amply borne out by simple observation of the American and other foreign makes of car one sees on British roads to-day.

In the matter of raw materials, castings, etc., the tale is still one of woe. A well-known Scottish firm recently placed a contract for 1,200 tons of iron castings in Belgium at 28 per cent. below British prices, and with guaranteed deliveries, which no British foundry could give them. It is also the case, according to Lord Weir, that new foundries are actually being built in Belgium and Holland to produce iron castings for the British engineering industry. To-day locomotive parts are coming from America to this country in spite of the exchange. More ridiculous still, it is reported that bricks are being imported from Norway and cement from Belgium. In face of all this, unemployment is rife and still increasing. On the railways wages have risen 310 per cent., and there are 29 per cent. more employees than in 1913. Assuming the railways are performing a substantially comparable carrying trade with that of 1913, transport is taking 29 per cent. more people to work it and costing 310 per cent. more in the process. One instance is given where two signalmen at 70s. per week are now required to deal with two trains each way per day, and have replaced one pre-war signalman at 23s.

Already foreign competition is making itself severely felt. Continental workmen are apparently content to work for lower wages and somewhat longer hours than our own trade unionists. Coupled with this, we have the recent news from the States where industries are already agreeing to big cuts in inflated war-wages rather than foster unemployment. Since the cost of labour enters into every single manufactured product, the only way in which we can regain our pre-eminent place in the world's markets is to reduce by every possible means the productive cost, improve the efficiency of all processes, and endeavour by every possible means to stimulate and increase output. It is therefore necessary for all associated with industry—employers and workpeople—to realise that nothing further must be done at the present juncture which will in any degree bring about an increase in the cost of production. On the other hand, every reasonable and justifiable step should be taken to reduce cost. Stability and confidence are the vital requisites in any campaign of improvement. Fixed prices, firm contracts and guaranteed deliveries are the elements in restoring confidence. But no one partner in industry is capable of infusing into it a new spirit; the writing on the wall must carry conviction to all parties, and the trade unions must respond as well as the employer, and justify their protestations of good faith and their sincerity for helpful co-operation.

And Unemployment.

Meanwhile, in the matter of the urgent need for handling the unemployment problem, an influential group of employers and representatives of Labour have for some months past been meeting informally to consider the remedy for this most pressing need of to-day. Obviously, the most disturbing factor in labour circles is the casual and variable nature of employment and the fear of losing one's job ever before the bread-winner. When trade is booming the good workman knows that his weekly money is an assured thing and he can devote his mind to his work with a comfortable feeling that he has a settled job for an indefinite period. When trade shows signs of slackening off, however, there is the ever-present fear of discharge at the end of the week due to no fault of his own, and such a weight on a man's mind must necessarily detract from the efficiency of his effort and affect the quality of his work.

It is desirable, then, to formulate a scheme if possible which will ensure a minimum payment to all employ-

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able persons even during such periods as are bound to arise from time to time in all industries, when there is not enough work to go round, and it is on this basis that the representative group above referred to have formulated their proposed scheme which aims at insuring all persons in receipt of £400 per annum or under, against absolute destitution in the event of unemployment. To this end a rate of benefit founded on fifty per cent. of the average earnings of the insured person, with ten per cent. additional for a dependent wife, and five per cent. additional for each child under sixteen, up to a maximum of 75 per cent. of the average earnings, or £5 per week is the basis of computation.

Benefits should be payable after three days' unemployment, and should be limited to one week's benefit for every six weekly contributions previously made, an adequate number of preliminary payments being credited to all bona fide workers at the initiation of the scheme. Benefits to be limited to twenty-six weeks in any one year. The scheme is estimated to cost, exclusive of administration, about 56 millions per annum, and contributions to this end would be made by wage-earners, the State, and the employer. For the worker, twopence in the pound is suggested; for the State, four millions and the cost of administration; for the employer, two per cent. on his wage bill. It is proposed that the scheme be stabilised on this basis for, say, five or seven years, at the end of which period statistics would be available for Government actuaries to reassess the contributions for a further term of years, and also to vary the employers' contributions in a given industry according to the prevalence of unemployment in that particular industry.

As regards administration, it is suggested that the method of administering the fund should be that set up under the Unemployment Act, 1920. Further, the promoters have been advised that with certain greatly needed and practicable alterations in the administration of the Employment Exchanges it will be possible to prevent malingering. The chief points in these novel proposals are thus:—(1) Unemployment benefit takes the form, not of a fixed amount, but of a proportion of the worker's regular wage, adjusted to the number of dependents; (2) Whilst the worker's and the State contributions are fixed, the employer's contribution varies, being made to bear the residuary cost of unemployment in his industry. Essentially the proposal is one to compel industry to create a wages equalisation fund, and to give employers an incentive to eliminate every removable cause of unemployment. As such it has much to recommend it, and we shall watch with interest its reception and criticism by the Government, which is faced with this most pressing problem of the day.

Cinema Studio Lighting.

At their last meeting the Illuminating Engineering Society again showed a characteristic instinct for the selection of topical subjects, and a great variety of technical experts (including cinema producers, lighting experts and ophthalmologists) were present at the discussion on "The Use and Abuse of Light in Studios for Cinema Film Production." At the moment special interest was given to the discussion by the reports of alleged injuries to eyesight caused by injudicious use of very bright lights in some studios. The Society provided an opportunity for the expression of views both of the adherents of this view and of its opponents. It is quite clear, however, that this particular problem is only a part of the wider aspects of the use of light in cinema studios.

I share the feeling of some of those who joined in the discussion that it should be possible to devise methods of lighting which come nearer to natural daylight, and that this, besides being better for eyesight, would probably also be in the interests of artistic film production. I notice that the Illuminating Engineering Society proposes to form a joint committee to inquire into all these questions, and, in view of the work the Society has already done by such means in other fields, the cinema industry should welcome their co-operation.

ELEKTRON.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

THE ELECTRICAL ENGINEER'S DIARY, 1921.—578 pp. and 92 pp. diary. (S. Davis and Co. 10s. 6d. net.)—We have great pleasure in bringing to the notice of our readers the thirteenth annual issue of this well-known diary. Year after year it has proved to be better and larger than ever before and this year we again notice important additions and improvements. When first published, in 1908, the diary contained 48 pages of information and was sold at half-a-crown. The present issue contains 582 pages of information and is sold at 10s. 6d. In other words, there is now twelve times the space devoted to sound, practical, technical information, but the published price has only been increased fourfold, notwithstanding the enormous increase in the cost of paper and printing during recent years. Obviously the diary is not only larger and better—it is also much better value for money than ever before.

In addition to extensive revision of all the existing sections, about 100 pages of fresh matter have been added in the new edition, notably with regard to electric cables, electric heating, cooking and cleaning, and electric vehicles and electric trucks.

The new chapter on electric vehicles and electric trucks is by Mr. Raymond J. Mitchell, whose name is well known to our readers. We regard the inclusion of these notes as being particularly appropriate to these times of high fuel costs. Sooner or later the electric vehicle will be of enormous value to British central stations and to British electrical industry as a whole. Already large numbers of electrics are in use, but their application in this country can only be said to have commenced. Articles such as the one now before us are of great educational value and, needless to say, there is in Mr. Mitchell's contribution a wealth of information drawn from practical experience and of great value to those who either intend to use electric vehicles or have them already in use.

The Diary amounts practically to an encyclopædia with all the data and information required for reference by the average consulting engineer, central station engineer and electrical contractor. Also, it may be regarded as a text-book of no small value to the younger generation.

For the convenience of those who wish to carry the diary about with them, an edition is available bound in limp covers and without the ruled memorandum pages.

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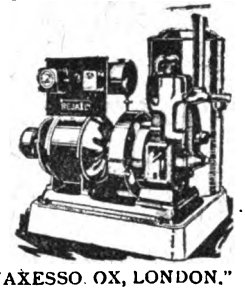
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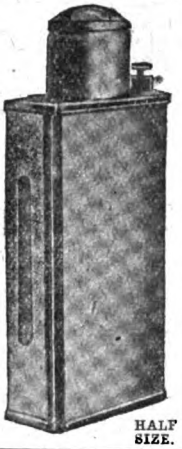
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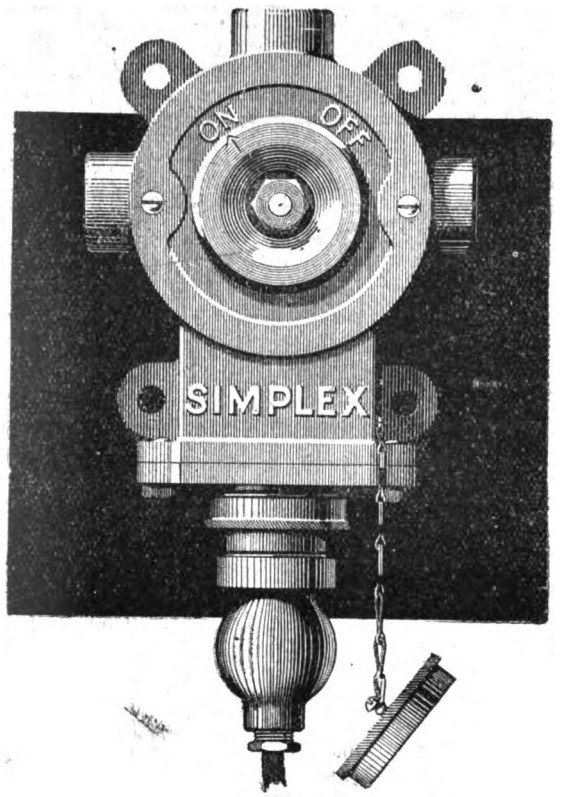
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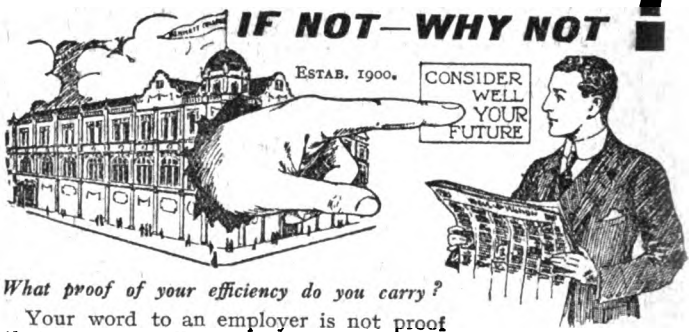
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Correspondence.

ELECTRICAL MEASURING INSTRUMENTS.

To the Editor of ELECTRICITY.

DEAR SIR,—I should like to take this opportunity of explaining a few of the points which do not seem to be very clear in my article on "Electrical Measuring Instruments."

As "W. J." points out, the force of gravity is represented in Fig. 1 by A.G. and not O.G. I think this mistake occurred in the printing of the article. Also, although the single force which replaces two other forces is often known as the resultant force, I think I am quite justified in using the term "restoring force" in this particular case, having regard to the fact that A.G. is the force endeavouring to bring the pointer back to zero, *i.e.*, to *restore* it to its normal position.

When referring to an instrument as following a "square" law I meant that the deflection of the pointer was proportional to the square of the deflecting force. This causes the scale to be crowded about the zero position and widened out at the higher values.

In the type of instrument shown in Fig. 3 it would, perhaps, be more explicit to say that the repulsive force will be proportional to the product of the strength of the induced poles. The law representing the distance between two poles does not affect this instrument to any great extent, owing to the fact that the two pieces of iron are not touching when the instrument is at rest, and that they are not deflected a considerable distance, even on full load. Strictly speaking, however, this law will affect the deflection, but the scale may be said, very approximately, to follow a "square" law, if the strength of the two poles are nearly equal.

In the instrument shown in Fig. 4 "this field will attract the disk into the bobbin by an amount proportional to the current," but since the small disk becomes a temporary magnet when current flows, this will also exert a force of attraction. This total deflection will be proportional to the square of the current.

It would, perhaps, be more correct to define "H" as "The intensity of the magnetic field, in lines per square centimetre produced by the permanent magnet." After which correction I think it will be seen that $\frac{H\,L\,N}{10}$ is a constant number.

Trusting that the foregoing remarks will prove to be of interest to your readers,

I remain, yours faithfully,

L. S.

To the Editor of ELECTRICITY.

DEAR SIR,—The article on Electrical Measuring Instruments by "L. S.," and the criticism of same by "W. J." interested me very much, and although the views expressed below may not be strictly true, nevertheless it is only by the exchange of opinions that one can confirm one's knowledge. Should I be wrong in any of my statements I trust that one of your readers will, as our American cousins so aptly put it, "put me wise."

As regards "Square Law," I have always understood that an instrument follows a square law when the working forces of the instrument are such that the current, or magnetic effect of the current, acts upon itself. *Example.*—The Kelvin balance. Of course, in an instrument of the hot-wire type, the heating of the wire is proportional to J^2R; if, as in good instruments, R is constant throughout the range of same, obviously the indications are proportional to J^2 and the instrument follows a square law.

As regards moving iron instruments, and more especially in this case, "Repulsion" type moving iron instruments, the following may help "W. J.":—

Let us imagine two pieces of soft iron—one fixed and the other attached to the spindle carrying a pointer—inside a solenoid. Obviously, if current is sent through the solenoid the two pieces of soft iron will repel one another and with a force proportional to the product of their respective pole strengths. If the permeability of the iron is constant throughout the working range of the instrument, the field due to each will be proportional to the current flowing and the torque at every point is proportional to the square of the current.

As regards the distance between the two pieces of iron, I don't think this enters into the question quite as much as "W. J." thinks. However, to go into this here would require more space than the Editor would allow me; suffice it to say that this affects the instrument more, I fancy, on A.C. than on D.C.

With reference to moving coil instruments, all, I think, that "L. S." has omitted in his formula is the term $\cos\theta$, where θ is the angle turned through by the moving coil about the axis of rotation.

The expression $T = KI$, where K is a constant, is generally defined:—

$T = a\ b\ N\ I\ H \cos\theta$ where a = breadth of coil, b = height of coil, N = number of turns, and I = current, H = strength of field, a and b are in centimetres and I in absolute units. In a first-class instrument K is constant throughout the working range.

Trusting that I have not taken up too much space,

I remain, yours faithfully,

G. H. S. T.

January 17, 1921.

100 PER CENT. LOAD FACTOR.

To the Editor of ELECTRICITY.

DEAR SIR,—I should like, through the medium of your journal, to ask the attention of Electricity Supply Engineers to the question of quoting special rates for appliances of fixed capacity working continuously day and night.

Some years ago an interesting device for storing energy in the form of hot water was introduced, and a good many supply undertakings did at that time quote low rates for the energy taken by this apparatus, using no meter and sealing the connections.

Recently a good deal of attention has been given again to appliances of this class, but inventors are being discouraged by the reluctance of supply undertakings to quote special rates for such supplies.

It is, I believe, argued that because the 100 per cent. load factor apparatus operates across the peak it does not justify cut prices for energy.

It must be remembered, however, that these appliances would be used to a great extent on parts of the mains network where loading is at present intermittent, and the load factor on the cables low. Moreover, in most stations, the actual peak occurs in the winter time and lasts for a very short period, and a rate might be calculated to take in consideration the overlapping of this short peak.

For example, if 8d. a unit is the price for supply taken on the peak and 1d. a unit would be profitable for, say, a 23-hour supply taken off the peak, it is obvious that an all-round figure of $1\frac{1}{2}$ would meet the requirements and probably encourage a very desirable load of this kind.

The matter should receive sympathetic attention because the water-heating problem is largely bound up with the storage of electrical energy on the consumers' premises in the form of heat. Moreover, there is indication to-day of further interesting inventions for heating, these probably await for their development only the encouragement of the supply engineer in the form of suitable tariffs.

It would be interesting if you could obtain the views of engineers on this subject.

Yours faithfully,

January 18, 1921. J. W. BEAUCHAMP.

Smoking Concert.—The second annual Smoking Concert held in connection with the Informal Meetings of the I.E.E., has been fixed to take place on the 28th February.

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THE USE AND ABUSE OF LIGHT IN STUDIOS FOR CINEMA FILM PRODUCTION.

An interesting discussion, introduced by Mr. J. C. Elvy, took place at the last meeting of the Illuminating Engineering Society, on January 18th. The earlier part of the introductory paper contained a brief historical survey of the development of the cinema industry, after which Mr. Elvy made some remarks on the general design of cinema studios. The nature of the structure of a studio was of great importance. Sometimes buildings were rushed up without proper advice, and were subsequently found too low in elevation or too restricted in area. In others an unduly low estimate had been formed of the amount of electricity required. There were a great variety of technical problems involved, such as the intensity of illumination, the actinic power of the various illuminants, and the desirability of methods of screening and diffusion of light.

This led him to refer to the alleged cases of injury to eyesight arising from exposure of the eyes to very powerful lights at close quarters. The position of an artiste who suffered in this way was somewhat obscure, and it was not clear how far studios came under the supervision of the L.C.C. and the Home Office. He attributed such cases of injury to eyesight to the injudicious use of concentrated "spot-lghts"; these he thought also gave rise to unduly sharp shadows and severe contrasts on the film, which were not really artistic. Was it not possible to arrange the artificial lighting so as to imitate more closely the natural diffusion of light characteristic of daylight? Mr. Elvy also referred to various difficulties that might occur in artificially-lighted studios, such as the incomplete lighting of certain parts of the scene. The arrangement of the lights involved a knowledge of illuminating engineering such as was applied in ordinary lighting problems, and he suggested that there was room for more scientific design in connection with the reflectors used with some types of illuminants for cinemas.

Another matter that needed careful study was the quality of light yielded by studio lamps. Undue attention was apt to be given to the visible brightness of the illumination produced, whereas the actinic effect was the important thing. From the photographic standpoint it was desirable to accentuate the ultra-violet; on the other hand, it was believed that excess of these rays might be prejudicial to eyesight. The address was illustrated by a great variety of lantern slides, many of them showing massed mercury vapour lamps, arranged both above and in front of the scene to be photographed.

Subsequently Mr. William Day showed a very interesting exhibit of objects of historic value, notably some of the very first lamps constructed for cinema work. One early form of arc lamp utilised two sticks of carbon, brought to incandescence by current supplied from a battery of Grove cells. Mr. A. G. Way showed some Westminster arc lights and discussed the comparative merits of open and enclosed arcs. He thought that in technical skill this country had little to learn from the United States. Mr. F. J. Hawkins exhibited some mercury vapour lamps, which yielded light with a strong ultra-violet component. The shorter wave rays, which were of little value for photography, were, however, checked by the glass envelope. In his experience no disturbance of colour-vision arose through the use of such lamps. Mr. Pullver alluded to the use of spot-lights and the value of portable searchlights in taking pictures out of doors. Mr. H. C. Carter showed a film which had been taken entirely by the light of gas-filled "half-watt" lamps which had advantages for the representation of coloured objects.

The Rt. Hon. G. H. Roberts, chairman of the Committee of the Ministry of Health on the Causes and Prevention of Blindness, referred briefly to the work of the committee, which had been asked to inquire into the effect on vision of lights in studios, and Mr. Alfred Legg (gen. sec. of the Actors' Association mentioned a case in which an artiste's back had been scorched by exposure to powerful light. His Association had no desire to hamper the industry, but he thought that proper precautions should be used in applying these lamps in studios. Others who joined in the discussion, including Capt. J. W. Barber, Mr. Kimberley, and Mr. Rowson, stated that in their experience cases of injury to eyesight had either not occurred or were extremely rare, and Mr. Lomas remarked that the instances he had met with had been only temporary. With the Kodak film neither the extreme ultra-violet nor the red end of the spectrum were of value, and both could be excluded without prejudice to the film.

Mr. L. Gaster, in winding up the discussion, suggested the formation of a joint committee, on which the Illuminating Engineering Society, the ophthalmologists and representatives of the cinema industry should co-operate, to inquire further into the technical problems that had arisen. He added that the list of queries exhibited at the meeting had been prepared by the Illuminating Engineering Society, independent of Mr. Elvy's address.

The new president of the Society, Mr. J. Herbert Parsons, who occupied the chair, briefly referred to his interest in the subject as an ophthalmologist and emphasised the facilities for co-operation with other bodies, which formed a leading feature in the Society's programme.

It was announced that the next meeting, to take place on Thursday, February 24th, would be devoted to a discussion on "The Use of Light as an Aid to Publicity."

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 109.

I have a motor starter with the resistance burnt out. It is 40 horse-power, 440 volts. How can I calculate the size and quantity of wire required to rewind this resistance to start against full load?—"ASTATIC."

QUESTION NO. 110.

How are water wheel generators got into exact step? With a steam turbine, a small hand or motor operated wheel will give a small amount of regulation of speed. Is a similar method adopted with water wheel generators?—"PHASE."

(*Replies to Questions Nos. 109 and 110 must be received not later than January 29, 1921.*)

Wanted, 10,000 Meters.—In our par, under this heading on page 44 of our issue of January 21, we omitted to state that the date for the presentation of tenders is March 29.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 28th inst., at 39, Victoria Street, at 8 p.m. Lecturette: "Manufacture of Portland Cement," by J. W. Wardell (Member).

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THE "SUNCO" COMES OF AGE.

Last Saturday the directors and the staff of the Sun Electrical Co., Ltd., spent a very happy and enjoyable evening on the occasion of the Staff Dinner to celebrate the 21st anniversary of the Company's existence. In all, about 114 were present, including directors, employees and visitors, with Mr. Beaver, the former General Manager and recently appointed Managing Director, in the chair. The committee responsible for the arrangement of this very pleasant function had provided a first-class musical programme, and the speakers who proposed or responded to the various toasts very wisely made them as brief as possible, although with due effect to the subjects on which they spoke. For instance, Mr. W. J. Rogers, the secretary, who proposed the Directors, said that they could not by any possible stretch of the imagination be looked upon as figure-heads. As a matter of fact, they were all workers, and as such possessed a thorough knowledge of electrical engineering, general engineering, and company finance. He referred particularly to the importance of the latter item, especially in view of the "Excess Profits Duty" or as he so aptly called it, "Extortion paralyses development." He stated clearly that industry needs facilities for development if it is not to be paralysed, and voiced the feelings of the entire staff in congratulating Mr. Beaver on his appointment to the Board as Managing Director. It must be a source of gratification and pride to them to know how he had brought the business to its present position, and, as Mr. Rogers so tactfully remarked, Mr. Beaver's elevation to the peerage (of the Board) had not altered him in the slightest. He was still just the same man to all of them, an expression which was received with much appreciation by all present.

In responding for the directors, Mr. R. Tweedy Smith mentioned that the Company was never so prosperous as to-day, and what is more, it gave every promise of continuing in that happy path. He referred to the fact that further premises had been leased from Messrs. Crosse and Blackwell, and that shrewd management had enabled them to carry on without being caught with heavy stocks on a falling market. He felt very glad indeed that they got on so well with their staff and employees. Mr. W. R. Rawlings who also responded, did so in a more humorous vein, referring facetiously to his unpunctuality in arriving at the office on Friday evenings in order to sign cheques, when he would invariably find Mr. Beaver dictating love-letters. (Much laughter.) He had joined the Board to see after the interests of the contractors, and he assured all the visitors that no improper discounts were allowed in consequence. He also referred to Mr. Beaver in very happy terms, and to the fact that it was largely owing to that gentleman's ability that the position of the Sun Co. in the electrical supply industry was due. What is more, he felt confident that the "Sun" will shine even brighter in the future than it has in the past.

Mr. Beaver proposed the toast of "The Staff," referring incidentally to the fact that the Dinner was held after the 21st birthday of the Company, which had originally been taken over from another undertaking based on German control, but that from the very date that the former undertaking was taken over, they had never employed foreigners in any shape or form, and whereas when the Company started the staff numbered from 16 to 20, it was now just over 150. He alluded with a smile to the fact that their catalogues did not contain instructions as to the way in which contractors were to carry out their installations, although on the other hand they had on their staff experts in all branches, who could give technical information if so required, but that it was not given unless asked for. The Company is now represented by agents in all the principal districts of the United Kingdom, and they expected shortly to be directly represented in the Colonies. In fact they had been asked to be represented in all parts of the world. For a long time past the business has been in a more or less congested state owing to the pressure of orders, and he admitted with regret that the Company's showrooms have on many occasions looked more like packing rooms, but that was due to the lack of space, and he was able to confirm with pleasure the statement made by Mr. Tweedy Smith that the Directors had been fortunate in securing the lease of certain factory buildings belonging to Crosse and Blackwell, and immediately behind the Sun Co.'s premises in Charing Cross Road. These would give over 20,000 sq. ft. extra area and would, he hoped, help them to carry on comfortably for several years. He said quite frankly, that the directors might initiate a policy, but its ultimate success would depend on the united efforts and loyal support of the staff, of which he had every reason to be proud. He also referred to the length of service of some of the employees. Many of those who were present had been with the Company over ten years, and of these, more than fifty per cent. had seen nearly twenty years' service. He also mentioned Mr. Morton, whose name was down to propose a later toast on the programme, as having been with them over ten years and having joined them in one capacity, had ultimately blossomed out in quite a different position on the Company's staff. Suitable replies to the toast were given by Mr. Phillips and by Major Huxley, the latter making various humorous references to the Sun calendar, after which an extra item was added to the programme in the shape of a speech by Mr. Beaver alluding to Miss Dewdney, who had been with the Company since its inception and to whose sound common sense and business acumen he was much indebted, as she had acted as his private secretary for many years. On behalf of the Directors he asked her to accept a small token of esteem and regard in the form of a handsome gold bracelet wrist watch, suitably inscribed, which was then presented to Miss Dewdney by Mrs. Beaver and fastened on her wrist. Miss Dewdney expressed sincere thanks for the gift, although words failed her to express her feelings at the surprise. She could, however, say quite frankly that if anyone wanted to keep on in the employ of the Sun Co., they had to work, and work well, and this was one of the secrets of the Company's success. Mr. Morton then proposed "The Press" about whom he made several flattering remarks, at the same time bringing in a few sly digs at the new sales controversy, and Mr. J. H. Cozens, of the Electrical Review, expressed the thanks of the fourth estate for the kindly hospitality of our hosts. The gathering concluded at a late hour by all present joining hands and singing Auld Lang Syne.

Tasmania.—A copy of the "Sixth Annual Report of the Hydro-Electric Department of Tasmania, for the year 1919-20, has been received from the office of His Majesty's Senior Trade Commissioner in Australia, and may be inspected on application to the Enquiry Room, Department of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1.

"Ar Pips" Dinner.—The annual dinner held by the staff of Messrs. Rashleigh Phipps & Co., Ltd., took place on Saturday evening last at "The Feathers," Broadway, Westminster, under the chairmanship of the popular founder of the firm. There was a large attendance and the subsequent entertainment provided by "home talent" resulted in a most enjoyable evening.

Cycle Lighting.—Now is the time when many of our readers are overhauling their cycles and preparing for pleasant rides in the early Spring time, and to all such, we would strongly recommend a perusal of an advert of the Alterna-cycle light, which appears in this issue. It will, we think, appeal to very many of them, and we hope to be able to give a good technical description of it in an early issue. Meantime, those interested should make early application for details as we believe that the makers are very full of orders.

Electrical Accessories for Uruguay.—The following are required:—47,000 plug fuses, 5 to 50 amps., 500 branching blocks, 115 cut-outs, 50 keys, 380 T.P. switches, 20 to 400 amps., 250 and 550 volts, 165 D.P. switches, 25 to 100 amps., 250 and 550 volts. Copy of the Spanish text of the conditions and blue prints can be seen in Room 48, Department of Overseas Trade, up to Saturday, 29th inst., after which date they will be available for transmission to firms unable to send to the Department. Sealed tenders, together with a deposit of 100 gold pesos (say, £21), must be presented at the offices of the State Power House, Montevideo, at 11 a.m on the 21st Feb.

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Various Items.

New Mill (Yorks).—The District Council has decided to confer with Thurstonland District Council on the electricity supply question, as by combination expense would be saved.

Burnley.—The tramways committee have accepted a Belgian tender for steel tyres at £37 10s. a ton. The nearest British tender was £59. The British pre-war price was £19 a ton.

Carmarthen.—The Electric Light Co. has applied for an increase in its charges for street lighting from the present 20 per cent. above pre-war charges to 50 per cent. A councillor stated that the extra cost entailed would need an additional rate of 3d. or 4d. The increase was refused.

Hebden Bridge.—At a meeting of the local Council it was agreed to accept the terms of Halifax Corporation for a further bulk supply of electricity, the Council's own works being unable to meet the needs of the district. It was also decided to increase the charges for electricity to 8d. a unit for lighting and 4d. for power purposes.

Otley.—This market town is greatly perturbed at not being included in the first batch of stations that are to be supplied with electricity in connection with the scheme for the constitution of a joint electricity authority. The Council have passed a resolution strongly objecting to the scheme unless Wharfedale is included amongst the first extensions.

New Club.—A new club has just been formed at Brighton. It is called the Electric Traction and Radio Club, and the subjects covered include all forms of Electric Traction, while the Radio Department covers Telegraphy, Telephony and Wireless. The chairman is Mr. R. W. Maidlow, of Homelea, 34, Bonchurch Road, Brighton, from whom all particulars may be obtained.

Preston.—A large eye magnet for the removal of fragments of metal from injured eyes has been installed in the operating theatre of the Royal Infirmary. The instrument has been designed by Mr. J. F. Simpson, tramway engineer, with the assistance of Mr. G. J. Gibbs, consulting electrical engineer. The cost was defrayed by workmen engaged in the metal trades of the district.

Haiti.—A contract has been settled between the Haitian Government and a firm at Jacmel for the erection of a hydro-electric light plant in that town. There is to be one generating station and one sub-station, the generating station being provided with two units each of 100 kilowatts, comprising a Pelton wheel driving a three-phase, 42-cycle, 600-volt alternator, with the necessary switchgear and acessories. The power is to be conveyed to the sub-station by an overhead line at 8,000 volts and the consumers' voltage is to be 220. Applications for the name of the firm in Jacmel should be addressed to the Department of Overseas Trade, 35, Old Queen Street, London, S.W.1, quoting 2619/FL/PN.

A New Journal.—We have pleasure in acknowledging receipt of No. 1, Vol. I., of the "Journal of Industrial Administration." This is the organ of the Institute of Industrial Management, of 110, Victoria Street, S.W.1, and is edited by Mr. Edward T. Elborne, who is an acknowledged authority on this particular subject, a subject by the way, which is of immense importance at the present time in view of the great difficulties which face the country in regard to the retention of its industrial supremacy in the markets of the world. The issue contains and abstract of an address on the industrial question by Viscount Haldane, O.M., an abstract of a paper on "The Influence of Exposed Records of Output," by F. M. Lawson, and a paper on "Road Transport as an Aid to Industrial Management," by R. Twelvetrees, A.M.I.M.E., together with details of the new Institution, Correspondence and other items. The price of the journal is 1s. 6d., and it will appeal to all who are interested in this particular subject.

Multi-Speed Electric Motors.—At the last meeting of the London Branch of the Institution of Mining Electrical Engineers, Mr. F. Creedy outlined some work that he has been doing in regard to multi-speed electric motors. The problem of providing change of speed in electric motors without the use of mechanical change-speed gear boxes is a fascinating one, and Mr. Creedy and others have been applying themselves to it for some years now with quite a distinct measure of success. The method of achieving this by arrangement of the winding is naturally extremely complicated, and yet the machines, when made, seem to work in a very simple manner. As a matter of fact, the multi-speed electric motor consists really of special windings placed in the casing of an ordinary motor. The Creedy machines have only been on the market for about twelve months, and have been built up to 25 h.p., although experimental machines have been built up to 150 h.p. These machines are driving machine-tool plant, such as radial drills, lathes, shaping machines, etc., where a certain amount of variable speed is wanted, and the feature of the Creedy machine appears to be the provision of a simple form of control which obviates the weaknesses of the usual resistance control. It is claimed that once the speed is set it can be relied upon more or less permanently to within 2 or 3 per cent. A paper on the subject will be read before the Institution of Electrical Engineers in the near future, when the whole question of the windings will be gone into in detail.

Trade Notes.

An attractive folder from **L. G. Hawkins & Co.** (110, Charing Cross Road, W.C.2.) deals with "Universal" electric irons and also with other "Universal" appliances such as grills, coffee percolators, toasters, heater pads, etc.

Messrs. R. B. Hand & Co., Ltd., Electrical and Mechanical Engineers, of 163, High Holborn, London, W.C.1., have been appointed sole distributing agents for the British Isles for Messrs. R. G. Haskins Company of Chicago, specialising in labour saving devices such as Portable Electric Drills, Grinders, etc.

Leaflet No. B.B.1197 recently issued by the **Edison Swan Electric Co., Ltd.** (Ponder's End, Middlesex), describes the "Ediswan-Acme" Portable Handlamp. A straight beam of approximately 100 c.p. is obtainable for a period of 12 hours continuous burning. The accumulator is the "Ediswan-Acme" 6 volts, 12 amp-hour type. The case is substantial, and the general arrangement of details very convenient.

Central Station Engineers and others who have to carry out insulation tests on cables, etc., will be interested in the "Metrohm" Insulating Testing Set which is manufactured by **Messrs. Everett Edgcumbe & Co., Ltd.,** the well-known instrument specialists of 117, Victoria Street, London, S.W.1, and the makers will be pleased to send a copy of their new catalogue sheet No. 37 to any trade reader on application.

English Electric & Siemens Supplies, Limited.—The Sales department of this Company (also of **Messrs. Siemens Brothers & Co., Ltd.,**) formerly trading at Central House, New Street Birmingham, have removed to new premises and in future their address will be:—**English Electric & Siemens Supplies, Limited.** White House, 111, New Street, Birmingham. Telephone: Midland 964. Telegrams: Siemens Birmingham.

The Midland Electric Manufacturing Co., Ltd. (Barford St., Birmingham), have just issued a series of ten slips dealing with some of their standard manufactures. These include the "Glasgow" Ironclad Switch, "Paragon" Switch, "Glasgow" Switch with "Kantark" Fuses, "Paragon" combined Switch and Fuse, "Memco" Changeover Switch, "Kantark" Cutouts, "Kantark" Fuseboard, the M.E.M. "Kantark" Combination board, "Traction" Knife Switches and the "Shielda" Fuse Bridge, the whole forming a series of items of general utility, and possessing many valuable features.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
FRIDAY, FEBRUARY 4, 1921.

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DEVELOPMENTS IN PRACTICE AND ART OF TELEPHOTOGRAPHY.*

By Nikola Tesla.

The recent successful experiment by Edouard Belin, of Paris, in the transmission of photographs between New York City and St. Louis, a distance of 1,000 miles, have naturally aroused a new interest in this rather old art. Mr. Belin's apparatus has been examined with a knowledge of previous efforts in that direction, and it must be admitted that the French inventor has achieved a marked improvement. It is true that his apparatus in many of its features is old and well known, but all the details have been worked out skilfully and his photographic reproductions are not only good likenesses of the originals, but are expressive in no small degree. In common with other arts the transmission of pictures to a distance has been brought to its present state of perfection by slow and gradual improvements effected in the course of 77 years. The literature on the subject is quite voluminous and difficult to peruse, as the articles are published in various languages and scattered through numerous periodicals. Only one complete and exhaustive work has been published in German, by Dr. Arthur Korn, of Munich, and Dr. Bruno Glatzel.

First Patents Taken Out Many Years Ago.

The original idea is due to Alexander Bain, a Scotch mechanician, who secured a British patent disclosing the invention in 1843. His plan contemplated the transmission of printed letters, drawings and pictures in the following way. At the sending station a holder with insulated metal points was arranged to glide in the direction of the lines over a frame resting on the printed page to be reproduced at a distance. Within this frame, and at right angles to its plane, a number of short wires were imbedded in sealing wax, their lower ends being in contact with the letters, which in turn were all electrically connected. As the holder moved back and forth the insulated metal points would be brought in and out of contact with the upper ends of the short wires, thus controlling the flow of the current through them. Each metal point was joined by a special line to the receiving station where there was a similar holder made to slide over chemically prepared paper laid on a grounded metal plate. When a battery at the transmitting end was connected with one of its poles to the letters and the other to the ground the current impulses traversing the line wires and the chemical paper would cause changes of colour in the latter, thus reproducing the characters. A great number of points and line wires were required to attain satisfactory results and, realising this objection, Bain proposed to avail himself of only one wire, but did not give full information in this regard. Subsequently Bonnelli and other inventors made improvements in his apparatus, reducing the number of wires to a few. There is no doubt that, despite the manifest crudity of this system, it was quite capable of being used commercially in the transmission of type as well as drawings and pictures, and may yet be found valuable.

The first practical success was achieved by an Englishman, Frederick Collier Bakewell, who secured a British patent in 1847 on a process, some features of which have proved to be indispensible in later years. He employed as a transmitter a cylinder on which the characters were written with insulating ink. A metal point bore on the cylinder and advanced slightly with each revolution of the same exactly as in the older form of phonograph. A similar cylinder covered with chemical paper and equipped with a sliding point was provided at the receiving station. The cylinder being grounded and a battery included in the line wire connecting the transmitting and receiving points, the passage of the current resulted in a discoloration of the paper and reproduction of the written characters at the receiving end. Considering the period Bakewell's apparatus was suprisingly perfect, particularly in the feature of maintaining the rotating cylinders in synchronism, for which purpose he provided an automatic as well as a hand correction. A controversy was waged between Bakewell and Bain for the honour of priority, but in this respect there can be no mistake. Bain was the originator of the idea, while Bakewell was the first to carry it out successfully.

Use of Chemical Paper Considered Impractical.

The use of chemical paper was considered objectionable, and in 1851 Hipp eliminated it, producing the impressions at the receiver with a magnet actuated by the transmitted impulses. It is curious, though, to observe that the modern art depends entirely upon this very device. In 1855 Casselli modified the Bakewell apparatus by employing carefully synchronised pendulums at the transmitting and receiving stations, thus replacing the rotary motion by a to-and-fro movement as in the Bain arrangements. Casselli seems to have had more enterprise than his predecessors, and the apparatus which he perfected in 1860 was actually used with some success for a short time in service between Paris and several other cities in France. Its abandonment was probably due to the slowness of transmission and lack of demand for this kind of facility. It is singular that many treatises on physics and other text books mention Casselli while ignoring Bain and Bakewell.

Shortly after this Meyer perfected a system which was used with success in France, and may be fairly considered as the first thoroughly practical application of ideas in this field. A curious improvement was made by Gérard who, in 1865, proposed the use of flat discs in place of the cylinders of Bakewell. Ever since one wire was adopted for the transmission it became an imperative necessity to maintain perfect synchronism between the transmitter and receiver, and many inventors devoted their energy to this task. D'Arlincourt resorted to tuning forks, and his idea was subsequently carried out in a more perfect manner by Lacour. At about this time the invention reached America, and in 1870 Sawyer brought his ingenuity to bear on the evolution of a process in which he employed zinc clichés. These were very reliable and constituted a signal advance.

In 1880 Edison devised an apparatus on the principle of that used by Sawyer, except that the impressions were produced on paper in bas-relief. The idea was carried further by Dennison in instruments of the reciprocating type. Through the introduction of the Tesla alternating system of power transmission a novel means was afforded for operating transmitters and receivers. The use of synchronous motors was proposed first in 1893 by Sheehy.

* *Electrical Review*, Chicago.

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DEVELOPMENTS PERMIT USE OF PHOTOGRAPHIC FILMS.

In all cases without exception it was necessary to provide an actual print, drawing or sketch to be transmitted until Lenoir introduced photographic films into the art, making possible the transmission of any kind of picture. This was a great step forward, but the honour of the first practical success belongs to an American engineer, N. Amstutz, who used photographic sending clichés in relief for the first time and with complete success. Amstutz was a true pioneer, and his improvement is essential in the carrying out of the modern processes. It is true that as early as 1865 a Frenchman, Hubert, had suggested the use of letters written with thick ink, but this was of little value, and Amstutz was undoubedly the first to produce and use the clichés on which the up-to-date art vitally depends. Perfectly satisfactory demonstrations were made with his devices in this country more than twenty years ago, when pictures were transmitted over telegraph wires to great distances. Samples of his work have been preserved which clearly show how much he was ahead of his time.

Following Amstutz, Dunlany, Palmer, Mills and other American inventors took up picture transmission with more or less success. By this time the necessity presented itself for increasing the rapidity of the process by greater speed of the devices as well as multiplex transmission. The Belgian inventor, Carbonelle, made an important improvement in this direction when he introduced the telephone diaphragm carrying a stylus for making the impressions.

Of all inventors, however, Dr. Korn was the most successful as well as prolific in the suggestion of improvements, his photographic method of recording carried out in 1903 being the most significant. The general idea of photographic recording had been already advanced by George Little, and a few years later Dillon took out a patent involving the use of sensitised paper and a mirror reflecting a beam of light on the same. But it is obvious that at that time it would have been hardly practicable to use this suggestion, as photography was not sufficiently advanced. In illustration of this it may be mentioned that in 1892 the attention of the scientific world was directed to a wonderfully sensitive receiver, consisting of an electron stream maintained in a delicately balanced condition in a vacuum bulb, by means of which it was proposed to use photography in the transmission of telegraphic and telephonic messages through the Atlantic cables, and later also by wireless. This proposal was met by insurmountable objections to the photographic method. Indeed, the Belin process has been rendered possible largely through the great improvements in the sensitive films which have been evolved in response to the urgent demands of the motion picture and also under the stimulus of the recent war.

SELENIUM CELL AND VACUUM TUBE USED TO TRANSMIT AND RECEIVE.

In the apparatus invented by Dr. Korn a selenium cell is used at the transmitter to vary the intensity of the sending current, and at the receiving station he employs a vacuum tube of high intensity which throws its light through a fine slot on a sensitive plate. The tube is excited by high-frequency currents supplied from a Tesla transformer and may be flashed up many thousand times per second. The motion of the receiver element is effected either by a wire galvanometer, oscillograph or telephone diaphragm. The Korn system has been used for some years past with success in Germany and other countries. In fact, it has been operated for some time even by wireless. Patents on this mode of transmission have been granted in 1898 and 1899 to Küster and G. Williams, but the arrangements involved the employment of Hertz waves and were impracticable. Later Frederick Braun, Pansa and Knudsen secured patents which, however, are equally defective. Success in this direction has been achieved so far only by Korn, Borjonneau and T. Baker. Invariably the inventors employ a wire galvanometer which is especially suitable for great speed. Telautographic transmission by similar means through wires as well as wireless is now common and is effected by employing a transmitter of two components, the original idea of which is due to an Englishman, Jones, who made that suggestion as early as 1855.

PRESENT DEVELOPMENTS INVOLVE MANY OLD PRINCIPLES.

To this short story of picture transmission Belin has contributed the latest chapter. The process he has finally adopted after many years of persistent effort involves the use of two cylinders rotating in synchronism—one for transmitting and the other for reproducing. The former is of copper and is prepared for operation by having its surface coated with a thin shellac solution, wrapping a carbon print of the photograph about it with its face to the cylinder and immersing the whole in hot water, this causing the gelatine to adhere to the cylinder surface in proportion to the degree of blackness so that a likeness of the print in bas-relief is obtained. On this cylinder bears the stylus of a microphone diaphragm which is slowly moved forward by the revolution of the cylinder as in a phonograph. In this manner the pressure of the carbon contacts is varied in conformity with the changes of the surface, and the microphone currents pass over the transmitting wire to the receiving station, where they cause corresponding deflections of a mirror forming part of a highly sensitive dead-beat oscillograph. A strong beam of light reflected from the mirror traverses a screen graduated from full transparency to opacity and is led through a microscopic opening to the sensitive film wrapped around the receiving cylinder. Special provisions are made to keep the cylinders exactly in step, as this is indispensable to good performance. The film is, of course, protected against the external light, and when the operation is completed it is developed as usual so that either a positive or negative print is obtained according to the position of the screen. There is nothing in his apparatus which is fundamentally novel; in fact, every feature of the same has been disclosed in the prior art. Even the graduated screen, which is one of the most essential parts, has been employed before by Dr. Korn. But Mr. Belin has displayed considerable ingenuity and skill in all the details, and his reproduced photographs are most excellent. There is every reason to believe that his efforts will be rewarded by an extensive practical application of his devices.

TELEVISION TO BE NEXT STEP IN PROGRESS OF TRANSMISSION.

The transmission of photographs constitutes only the first step towards the immeasurably greater achievement of television. By this is meant instantaneous transmission of visual impressions to any distance by wire or wireless. It is a subject to which I have devoted more than 25 years of close study. Two of the impediments which years ago seemed insurmountable have been successfully overcome, but great difficulties are still in the way. These are encountered in the inertia of the sensitive cells and the enormous speed required to make possible the vision of persons, objects or scenes as in life. It is the problem of constructing a transmitter analogous to the lens and retina of the eye, providing a medium of conveyance corresponding to the optic nerve, and a receiver organised similarly to the brain. It is a gigantic task, but I am confident that the world will witness its actual accomplishment in the near future.

The Dynamicables.—The next dinner will be held at the Trocadero Restaurant, on Tuesday, Feb. 8, 1921, at 7.30 p.m., Sir James Devonshire, K.B.E., in the chair.

A Good Testimonial.—Messrs. Johnson & Phillips, Ltd., Charlton, S.E.7, have just received an order from the G.P.O. Engineering Department for a duplication of the London to Brighton trunk telephone cable laid by them in 1914. This cable consists of approximately 55 miles of 104 pair of 70 lb. dry core, lead covered cable, and is in addition to considerable mileage of trunk telephone cable which the firm have in hand for other sections of the G.P.O. telephone system.

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BRITISH INDUSTRIES FAIR (BIRMINGHAM) 1921.

This fair, which is to be held at Castle Bromwich from February 21st to March 4th, shows every sign of being an even greater success than that of last year.

Large numbers of inquiries are being received from colonial and foreign buyers, and all indications go to show that the Fair will be well patronised from abroad. The exhibits themselves will be more comprehensive and far more representative of the various trades allotted to this section of the Fair than was the case in 1920.

The Duke of York will be present on March 1st, and is expected to travel from London on the morning of that day, returning the same evening. His Royal Highness will be entertained at lunch in the city by the Lord Mayor, and will later spend several hours at Castle Bromwich viewing the exhibits.

The visit of a number of official foreign commercial missions invited to this country as guests of the Government coincides with the date of the Fair, to which a visit will be paid on March 2nd. These missions represent about 16 foreign countries—and will be—while in Birmingham—the guests of the Council of the Fair, who will entertain them to an official luncheon and dinner, at which the Lord Mayor will preside.

Further, there is every reason to believe that the President of the Board of Trade (Sir Robert Horne) and the Parliamentary Secretary to the Department of Overseas Trade (Mr. E. G. Kellaway) will visit Castle Bromwich, and that, in addition, the High Commissioners of the various British Diminions will also be present.

The Lord Mayor, who is also the president of the local section of the Fair, will attend on the opening day in his official capacity, but there will be no formal opening.

Intending visitors are recommended to make immediate application with regard to hotel accommodaton to the General Manager, 95, New Street, Birmingham.

B'HAM AND MIDLAND INST. EXHIBITION.

At the above exhibition—which was held from January 11th to 14th—the Edison Swan Electric Company, Ltd., exhibited on their stand an extensive range of X-ray and electro-medical appliances.

The high-tension generating unit comprised a 16-inch "Jointless Section" induction coil and a "Premier" mercury interrupter, fitted with an Ediswan mechanical high-tension rectifier. Both of these articles are manufactured at the company's Ponders End works under the personal supervision of Mr. Leslie Miller, A.M.I.E.E.

The X-ray couch exhibited was of the very latest design, with fully protected underslung tube box. In addition to the lead lining inside the tube box, further protection from the rays is effected by a lead-lined wooden panel which faces the box and works in conjunction with it.

Amongst the Ediswan electro-medical exhibits that which attracted most attention was the Ediswan portable high-frequency and cautery generator. This is a most compact and efficient instrument with a remarkable output. In addition to generating high-frequency current suitable for all purposes, it is capable of heating both large and small cautery burners. The gross weight of this instrument is only 10 lb. Another article of special interest was the Ediswan "Saloon" electric hairdryer. This is adaptable for use either on a stand or as a hand model. A very large amount of hot air is produced, the heating element taking 600 watts.

In addition to the above a very wide range of electro-medical appliances was exhibited.

KELVIN MEDAL, 1920.

At a meeting of the Award Committee, consisting of the presidents of the principal representative British engineering institutions, held in London on Tuesday, January 25th, the first triennial award of the Kelvin Gold Medal was made to Dr. W. C. Unwin, F.R.S., he being, in the opinion of the committee, after their consideration of representations received from leading engineering bodies in all parts of the world, the most worthy to receive this recognition of pre-eminence in the branches of engineering with which Lord Kelvin's scientific work and researches were closely identified.

The arrangements for the presentation of the medal will be announced shortly.

The Kelvin Gold Medal was established in 1914 as part of a memorial to the late Lord Kelvin, and in association with the window placed in Westminster Abbey in his memory by British and American engineers.

THE LIGHTING OF THE BUTE SAW MILLS.

A complete change over from antiquated to modern lighting has just recently been carried out at the Bute Saw Mills, Luton, where bat's-wing gas burners have been superseded by Mazda Gasfilled lamps in Mazdalux reflectors. An average intensity of 6 foot-candles is obtained with an expenditure of only 0.7 to 0.65 watts per sq. ft. In the main shop, which measures 125 ft. by 66 ft. by 10 ft high, many



FIG. 1.—GENERAL VIEW OF MAIN SHOP AND BALCONY BY ARTIFICIAL LIGHT.

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circular saws, band saws, and planers are in operation. The lighting units, each comprising a 100-watt Mazda Gasfilled lamp in an intensive Muzdalux reflector, are 58 in number and are uniformly spaced. They are erected so that the mouths of the reflectors are level with the lower surface of the beams in the ceiling. This not only permits of the reflectors being mounted at the proper height, but has the further advantage of preserving the units, to some extent, from the mechanical damage to which they would otherwise be especially liable in a place where long planks and beams, etc., have to be manœuvred.

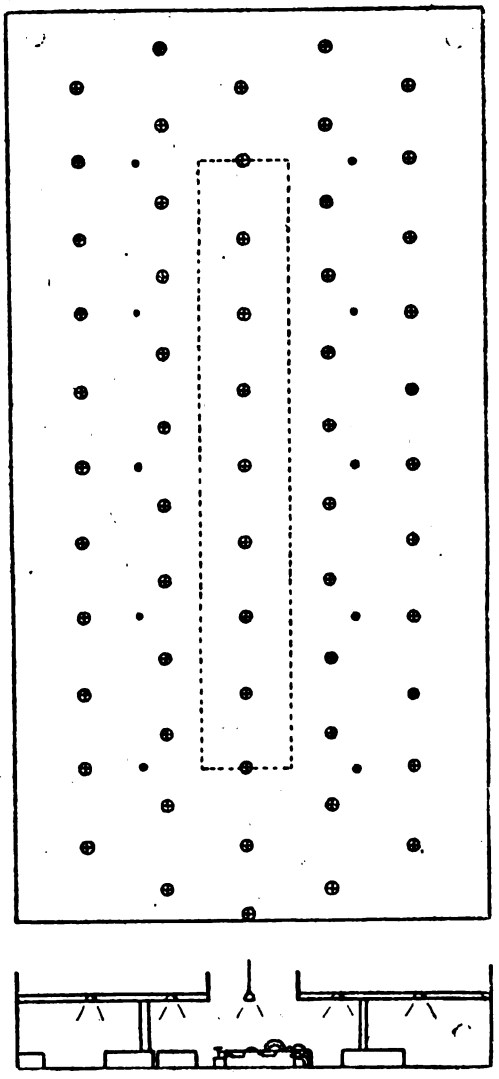


FIG. 2.—LAYOUT OF MAZDALUX UNITS IN MAIN SHOP. THE BLACK DOTS REPRESENT THE PILLARS SUPPORTING THE CEILING. THE LOWER DIAGRAM SHOWS DETAILED ARRANGEMENT OF UNITS IN RELATION TO CEILING BEAMS.

There is a rectangular opening down the middle of the ceiling in the main shop. The first floor is, in effect, a balcony to the ground floor. It will be noticed from the illustrations that a somewhat unusual, although essentially reasonable arrangement has been adopted in the placing of the light units over this opening. As a rule, in such cases the units would be suspended at the same height as those on the balcony or upper floor. Of course it is easier to do this, but from the lighting point of view such a procedure is obviously illogical, since the area which needs to be illuminated is at the bottom of the well. At the Bute Saw Mills, the lights in the opening are fixed on a level with the ground floor ceiling, with the beneficial consequence that the illumination in the middle of the main shop is equal to that at the sides.

In the carpenters' shop, the Mazdalux system of lighting is also used. This shop measures 141 feet by 26 feet 6 inches, and is equipped with 24 intensive Mazdalux reflectors and Mazda Gasfilled lamps.

Further particulars of this installation, designed

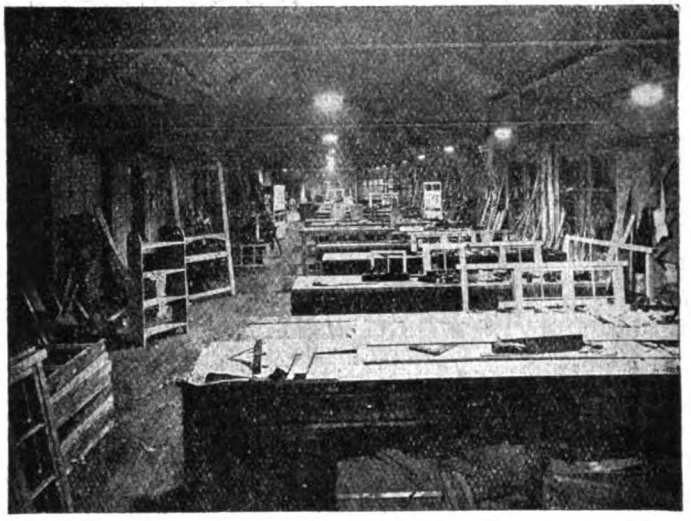


FIG. 3.—CARPENTERS' WORKSHOP BY ARTIFICIAL LIGHT.

by Mr. C. J. Mills, A.M.I.E.E., Consulting Engineer, may be obtained from the Illuminating Engineer's Department of the British Thomson-Houston Company, Ltd., 77, Upper Thames Street, London, E.C.4. The activities of this department are chiefly of an investigatory and advisory nature, and its expert assistance is, we understand, at the free disposal of any factory owner, manager or engineer who is interested in the subject of efficient lighting.

NOVELTIES IN ELECTRIC HEATING.*

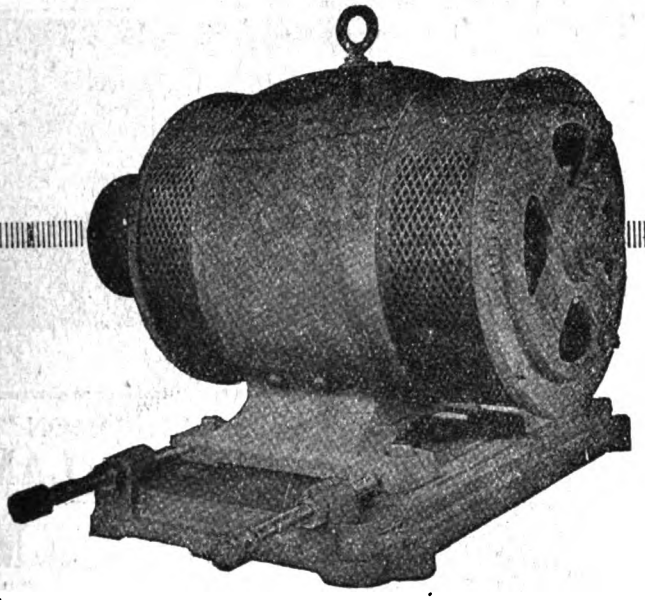
Recent improvements by the A.E.G. in the design of heating elements are described in a recent issue of the *A.E.G. Mitteilungen*.

The lack of mica during the war led to the discovery of an insulating cement, which is claimed to possess considerable advantages over the former. The fine wire construction for ovens was abandoned in favour of a heating-tube construction of much greater mechanical strength, which in the case of water heating can even be used under certain conditions as hot-water piping. Heating elements are shown of a cylindrical ceramic material coated with cement. Hot-plates, etc., are made on the same principle. These elements are claimed to have an extraordinarily long life and to admit of higher temperatures than mica insulated elements. The heating tubes consist of a spiral metal tape insulated with asbestos between the turns, so that the current flows spirally, although mechanically the whole forms a continuous tube, fixed at the ends into strong porcelain sockets. These tubes are applicable to numerous heating and drying purposes, even to very large apparatus, such as steam super-heaters, boilers, etc.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 4th inst., at Caxton Hall, at 8 p.m. Lecturette: "Surface Tension and some of its Industrial Applications," by W. H. Ballantyne, B.Sc., F.C.S. (Member). Also on Friday, 11th inst., at Caxton Hall, at 8 p.m. Lecturette: "Notes on some Limit Gauges," by F.A. Simpson (Member), Slides and Exhibits. And on Friday, 18th inst., at 39, Victoria Street, at 7 p.m. Social evening. New members specially invited.

* *The Technical Review.*

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SWANSEA: Electrical & Mechanical Trades Supply Co., Russell Buildings, St. Mary Street.
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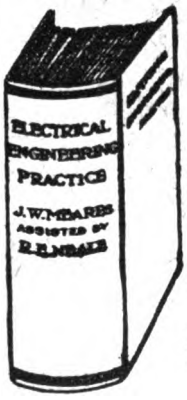
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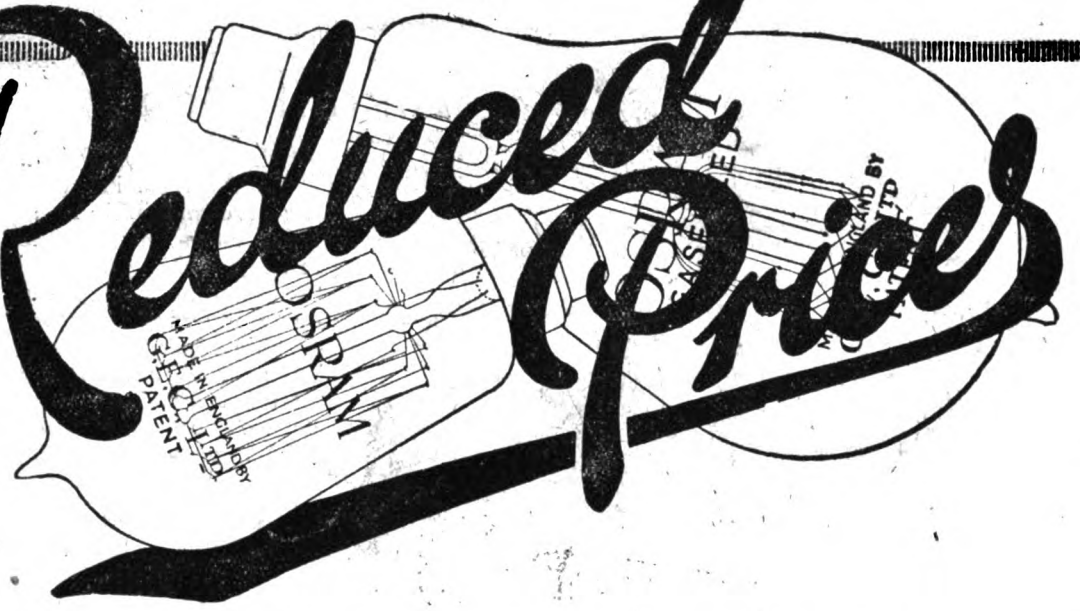
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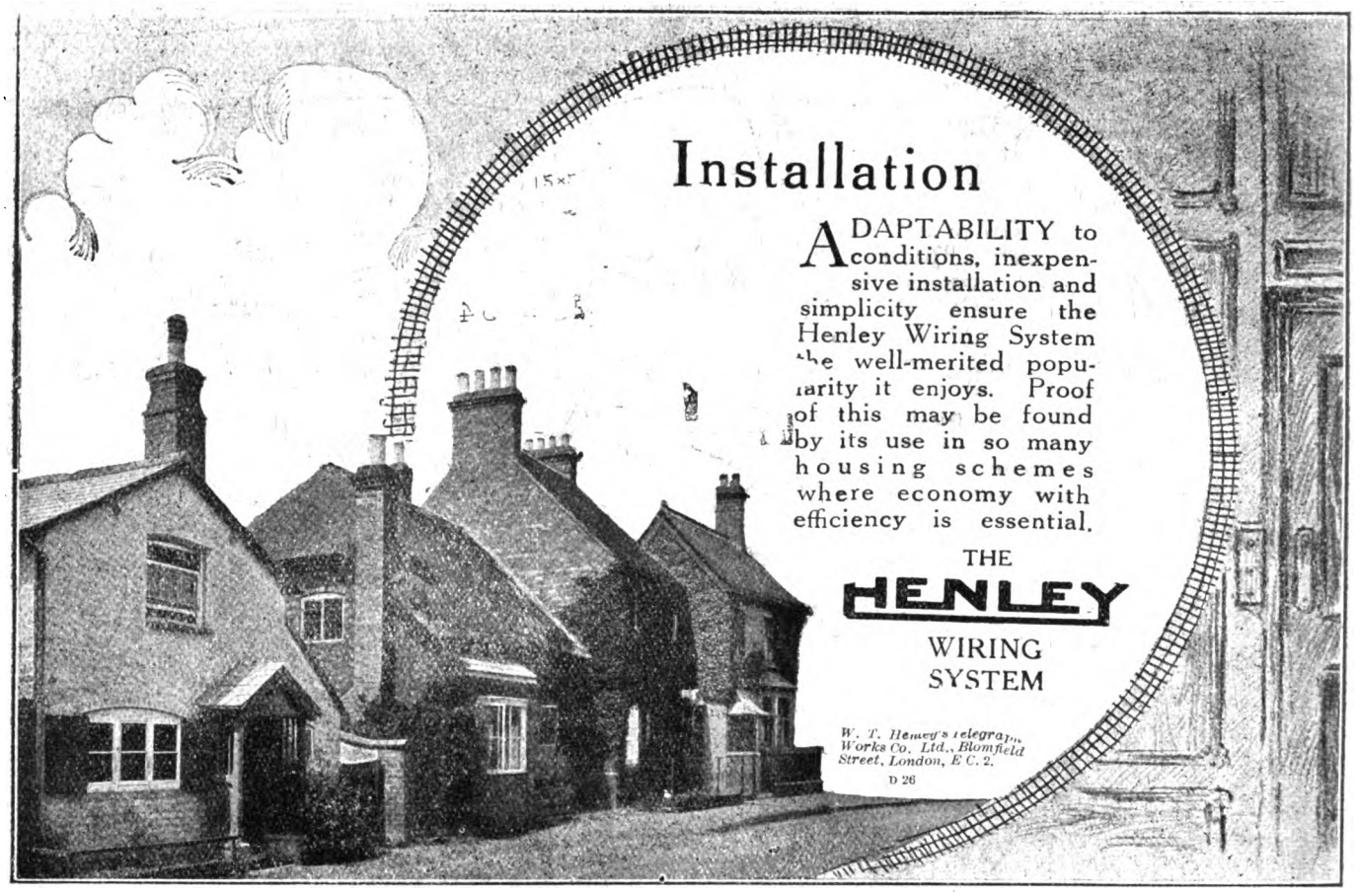
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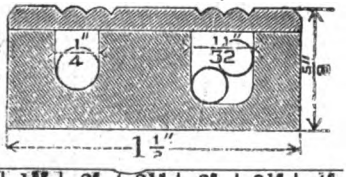
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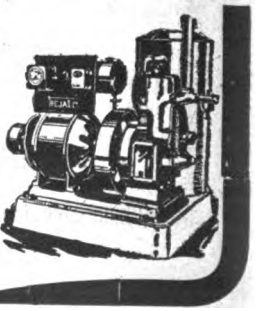
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

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Current Topics.

Electricity Supply Failures.

Temporary failures of electricity supply, due to a variety of causes, *e.g.*, faults in distributing systems, plant breakdowns, switchgear mishaps, etc., have been all too frequent during the past twelve months. Scarcely a week passes without its report of electric light failure, causing infinite inconvenience at critical hours, usually when places of amusement are at their busiest, or when shops and business premises are in full swing. These breakdowns used to be conspicuous by their rarity, but, since the war, they have become alarmingly frequent and threaten in the aggregate to bring electricity into disrepute as an unreliable means of lighting. Whether the cause of most of these failures is directly attributable to excessive wear and tear accompanied by lack of much-needed renewals arising out of the war, or whether they indicate a tendency towards slackness on the part of those responsible for maintaining these public services, it is difficult to say, but the fact remains that every responsible supply engineer should be on his guard against a recurrence. Total breakdown in gas supply is an extremely rare occurrence, and only accompanies a badly broken main or a failure in coal supply. Even in time of shortage there is usually a few days' reserve in the gasometers at every gasworks of consequence.

Motor-Bus v. Tramway.

The battle of the systems is being fought out in various parts of the country, and the ancient City of Chester is about to consider the relative merits of spending a considerable sum in putting its electric tramway tracks in order, or, as an alternative, selling its rolling stock and permanent way, and substituting motor-buses. In the case of Chester there can be only one solution. With its narrow congested thoroughfares and comparatively short routes a motor-bus service is the only possible system of transport, and the present tramway system, which is comparatively modern, should never have been installed when the original horse cars were abolished. Chester is the gateway to North Wales, and during the summer months an enormous volume of motor traffic passes through its narrow main streets, the trams having difficulty in negotiating the crowded thoroughfares, whereas handy up-to-date motor-buses would be well adapted for this form of traffic.

Owing to its antiquity and the plans of the city, it is practically impossible to adopt street widening methods, and to perpetuate the tramways in face of the ever-growing motor traffic problem would be a gross error on the part of the civic authorities, quite apart from the financial aspect of the situation. Chester may well look to Taunton for a lead in this matter; as I reported in these notes a short while since, Taunton Council was offered the tramways at a bargain price as an alternative to a withdrawal of the service. The council wisely decided to refuse the offer rather than saddle the town with an annual loss on a service which, in the light of modern operating expenses, could never have been made to pay its way.

An Eccentric Will.

Publishers as a class are not addicted to eccentricity; as a rule they are not rich enough to practise the hobby, but a Kansas member of the profession would appear to be the exception, if report speaks truly. By his will, Sam Radges, publisher, of Topeka, Kansas, directed that a certain newspaper was to be left daily on his grave for the next twenty years. He paid the whole subscription in advance, and gave his vault in the cemetery as the address. An electric lamp has been installed in the vault and is to be left burning *for ever*. It will be interesting to note the action of his executors should the supply authority fail to maintain the requisite supply of current. Also, what was the object? An average bulb radiates so little heat that it can scarcely be surmised that the deceased wished to become acclimatised—as it were—beforehand. In any event, he was too queer to remain living.

What Will It Cost?

We are not very good propagandists in this country so far as popularising electricity is concerned. With the exception of the E.D.A., which works hard and well towards that end, and the individual efforts of not altogether disinterested electrical dealers and wiring contractors, practically nothing is done either by personal canvass or advertisement to prompt the average householder either to become a consumer, or, if he already has a supply, to increase the number of utilities for which he consumes current. The intolerant and arbitrary attitude of supply officials in the past has had a good deal to do with our public apathy towards electrical service. In the States and other countries electricity is everywhere, and is used for practically every domestic duty imaginable—from cleaning knives to drying hair.

Over here we stick a few electric irons, or kettles, vacuum cleaners and radiators, in a prominent shop window and expect the public to do the rest. That is essentially NOT the way to secure fresh converts to the cult of electricity for the household. It should be the duty of every supply authority to see that every householder within the area served by its mains is thoroughly educated up to the possibilities not only of electric lighting, but of every other domestic application of the juice. Comprehensive non-technical literature, well and attractively illustrated, should be thoroughly circulated in every street, with full instructions as to how to set about securing a supply and examples of the cost of installations of various kinds suited to the particular class of residence in that street.

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After all, the main consideration is £ s. d., and the first question the prospective user asks is: What is it going to cost? If he has no existing installation he naturally wants some idea of the initial outlay, together with the incidental expense of obtaining a service and the hire of a meter—if on a rental basis. Then he should be told something about the number of units he is likely to consume (a) for lighting, (b) for household appliances, (c) for heating, (d) for cooking, and so on. One of the principal obstacles to the greater sale of electrical appliances is the appalling ignorance which prevails as to the cost of operating them. Even in electrical circles very little is known of the cost of operating quite familiar contrivances such as cookers, fans, vacuum cleaners and the like.

I heard two electrical men discussing a certain appliance in which both were actually interested from a sales standpoint, and neither was confident of the probable cost of operating the appliance over a given period. It is no use telling an ordinary householder that you are offering him a 500-watt kettle or a 2-k.w. fire. The term conveys nothing to him, and rumour has probably been busy beforehand with gigantic quarterly accounts for current as the result of installing one of these new-fangled (*sic*) devices. Go to the public with your fan, cooker, iron kettle, vacuum cleaner, washer, or any other gadget, work out the cost of operating beforehand, and tell him honestly what it is likely to cost him at the same time as you are descanting on its virtues. A little more push and publicity in this direction would work wonders in the accessory market. The need for such educational tactics is evident from the fact that a leading London daily is already attempting to inform its readers on this vexed question of cost of working domestic electric appliances.

German Competition.

However much we like to argue from time to time that politics should find no place in industry, it has become a practical impossibility, at any rate under the present conditions of international trade. This was never more clearly demonstrated than in the discussion at the annual meeting of the Machine Tool Trades Association, when the British manufacturers declined, by a large majority, to adopt a resolution that they, so far as the members of the Association are concerned, should be debarred from dealing in German machine tools. It is a matter which has an extreme interest for the electrical industry from the purely business point of view, without any question really as to whether one political creed is better than another.

It is not at all uncertain that a good deal of so-called British machinery which is now being sold to us at high prices consists of a fair proportion of Continental raw material, and, if Britishers are to pay high prices for British goods, then it is only logic that they should be made of British materials throughout. At any rate, Continental castings are coming into the country at £40 per ton below the prices asked for here, and it is straining the frailty of human nature too much to suggest that they are not being purchased and incorporated in British machinery.

Perhaps it is the knowledge of this which resulted in so many British manufacturers of machine tools voting against the restriction of the importation of machine tools. However that may be, the point of interest to the electrical industry is that if, as is admitted, German machine tool makers can underquote us to the extent of 50 or 70 per cent., it means that the output of electrical firms, who necessarily use machine tools, is going to be dearer to a considerable extent than if they are left a free hand to purchase in the cheapest market. It is a difficult subject to dogmatise upon, but we seem to be in the anomalous position that we must assist the Germans to re-establish their trade in order that the unfavourable position of the exchange may be restored more to the normal, because as that stage is approached the better will be our possibilities of competing with them in the world's markets.

Just at the moment there is a loud outcry in favour of protecting the British magneto industry, in which so many electrical firms are now interested, and the attitude of the British machine tool makers in regard to foreign imports is one that will undoubtedly attract attention in connection with this and the promised Bill of the Government. In this matter we are all naturally pulled in two directions, because we wish to buy as cheaply as possible and, at the same time, buy in the British market if it is at all possible. It will certainly need a Solomon to provide a way out.

Perhaps, after all, we should not do badly by taking seriously to heart Lord Weir's advice at the annual dinner of the Machine Tool Trades Association, which followed the discussion on the importation question. Lord Weir puts the whole industrial position into a nutshell when he asks us why we select so definitely as the main cause of our present difficulties the impaired purchasing power of other countries, when it is quite apparent that, to a large extent, that phenomenon is far more an effect than a cause. He asks whether the situation is not governed to a very large extent by the fact that our enhanced costs of production and consequent prices have virtually closed our markets, and suggests that, if our customers are poor, surely we must provide for them products at a price they can afford to pay. This brings us right down to the cost of production in this country, which hinges solely upon the cost of labour and materials, and we are never likely materially to assist the situation by any protective legislation or manipulation of currency or credit unless we assist any such process by revising and amending our industrial conditions of working in the light of ordinary common-sense standards; in other words, that long-desired harmonious co-operation between employers and employees is the real panacea.

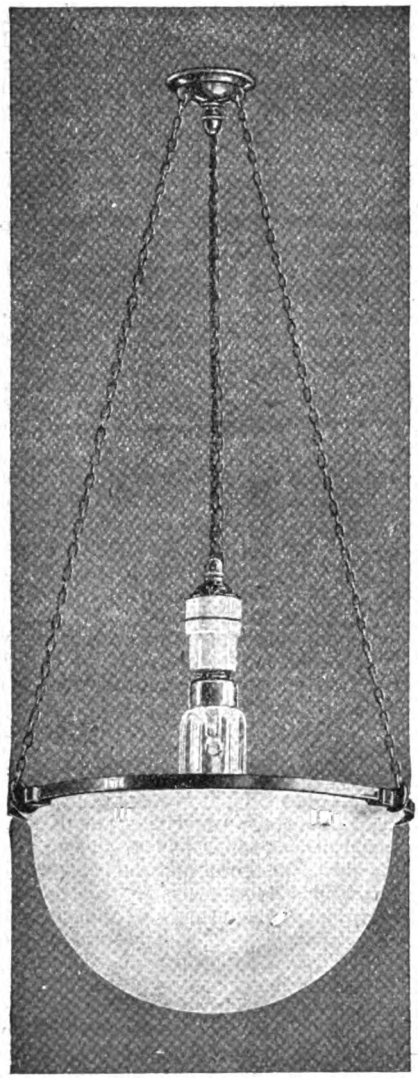
ELEKTRON.

Water Heating and 100 per cent. Load Factor.—With reference to the letter from Mr. J. W. Beauchamp, published in ELECTRICITY Jan. 28, 1921, p. 55, readers will be interested to know that the whole subject of load factor, the electrical heating of water, and electro-thermal storage systems, are treated very thoroughly in "Electrical Engineering Practice," by Meares and Neale (25s. net, 25s. 9d. post free from ELECTRICITY offices). This book of course contains a vast amount of other information of value to the practical electrical engineer.

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C.C. WORK.

Solutions to Questions set at the 1920 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page 23.*)

Q. 11.—How is it that a synchronous motor working at constant potential difference can maintain a given mean torque when the current in its excitation coil is varied?

A. 11.—Suppose the excitation of the synchronous motor to be such that the e.m.f. induced in the armature is practically the same as the applied voltage, then the phase relationships between the various quantities are approximately as indicated in Fig. 9, where *OV* represents the applied voltage, and *OE* the voltage induced in the windings. *OV* and *OE* are nearly in phase opposition, the angle θ being dependent only upon the load. *OR* is the resultant of *OV* and *OE*, and is the voltage available to send current through the impedance of the windings; and since the reactance of the latter is far greater than its resistance, current *OI* will lag nearly 90° behind *OR*, and is therefore almost in phase with *OV*; *i.e.*, the power-factor

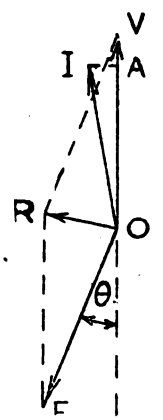


FIG. 9.

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under these circumstances is practically unity. *OA*, the projection of *OI* on *OV*, represents the active component of the current. It is this component acting in conjunction with the magnetic flux that serves to produce the torque exerted by the machine; and for a given mean torque, the power component *OA* of the current must remain constant.

Next, suppose the excitation to be increased so that the induced e.m.f. reaches the value indicated in Fig. 10. *OR* again represents the resultant of *OV* and *OE*, and *OI* is the current, the angle of lag of *OI* behind *OR* being exactly the same as in Fig. 9. Since the load is unaltered, angle θ] remains the same. The

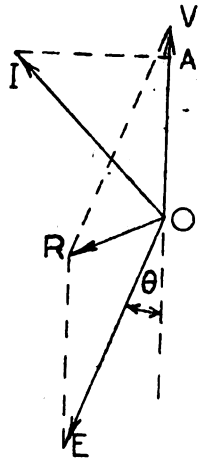


FIG. 10.

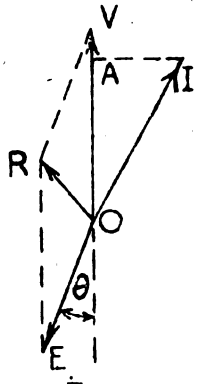


FIG. 11.

current, however, has increased in magnitude, but owing to the greater phase difference between *OV* and *OI*, the power component *OA* is practically the same as in Fig. 9, so that the motor is still exerting the same torque. Further, the armature reaction due to a leading current in a synchronous motor is such as to weaken the field, so that the forward shift in the phase of the current tends to neutralise the effect of the larger exciting current.

If the excitation be decreased below its normal value, we have the conditions depicted in Fig. 11. The current *OI* now lags behind *OV*, but the power component *OA* is practically unaltered. Also, a lagging current in a synchronous motor sets up a magnetising armature reaction and thus tends to compensate for the smaller exciting current and to maintain the induced e.m.f. at a value nearer that indicated in Fig. 9.

It will be seen from the above figures that a synchronous motor is a self-regulating machine in regard to the current taken to supply a given torque under various conditions of excitation.

(To be continued.)

The Westminster Tool & Electric Company, Westool Works, Putney Bridge Road, S.W.15, have appointed Messrs R. S. Newton & Co., of 29, Fountain Street, Manchester, as agents for their Westool Portable Electric Drills and Blowers for the County of Lancashire.

Messrs. H. W. Smith & Co. (1920) Ltd., Electrical Wire and Cable Manufacturers, of Lydbrook, Glos., have appointed Mr. Ashley P. Pope as Sales Manager of the Company, and his headquarters will be at the London Office, Central House, Kingsway, from which address all orders and enquiries will be dealt with, and where he will be delighted to see old friends. The Telegraphic address is: "Virwires-Westcent-London," and Telephone No. Regent 2368.

TEMPERATURE LIMITS IN ELECTRICAL PLANT.

There is a determination on the part of electrical engineers to become more closely acquainted with the actual conditions inside plant and apparatus. This desire has been stimulated in the main by the high costs of manufacture, and if we take the question of temperature limits only, it is quite clear that in so far as these can, with safety, be increased, a cheaper machine must result. Already this session at the Institute of Electrical Engineers there have been two papers dealing with the effect of temperature upon buried cables, and there is conclusive evidence that central station engineers, whilst paying the most minute attention to the generating plant, up to a point, have neglected the mains, possibly because they are out of sight. The tendency now, however, is to provide means for recording at the central stations the temperature inside the mains at various parts in such a way that the station engineer will be able to tell at a glance, at any moment, what the condition of his mains is. It is but a short step from this to a desire to acquire knowledge of the actual temperature conditions inside electrical plant and particularly large turbo-alternators. The fact here, is that although these machines are sold on the basis of a certain temperature limit, in actual practice the temperature is much higher due to the airways becoming choked with dust and also to the lack of means for ascertaining the temperature inside the coils, and so on. The common practice is to test the temperature by means of a thermometer, placed on the most accessible outside part with the result that the machines have to stand up to temperatures much higher than those stated in the specification. In view of this fact, most manufacturers of large turbo-alternators agree with the plea put forward in a paper before the Institution of Electrical Engineers on January 27 by Mr. G. A. Jublin that, in order to produce cheaper machines, a matter of vital importance just now, higher temperature limits should be adopted; indeed the temperature limits which machines now run to, more or less unconsciously to the engineer, for the reasons stated above. Coupled with this, however, is the recognition that more accurate temperature measuring appliances must be evolved, and the use of thermo-couples imbedded in the parts of the machine, the temperature of which it is important to know, is suggested. In this way it is put forward that an ultimate temperature of 160 deg. C., could be adopted instead of the nominal one of 125 deg. C., as at present. Testing temperature in this way, however, is new, although it is said that machines are sold and accepted in America with a temperature limit of 150 deg. C. Manufacturers on this side, however, would hardly be likely to give guarantees in the present state of development of such thermo-couples or other devices. The position, therefore, comes to this; that manufacturers appeal to users of these large machines to co-operate with them by adopting higher temperatures and methods of measurement, keeping in touch all the time so that the results of the experience so gained can be taken advantage of. In regard to cables, the north-east coast power companies assisted the cable makers, considerably, by taking certain risks and so leading the way, and in the matter of large turbo-alternators, these power companies—in other words, Mr. C. H. Merz—and no doubt others, are willing to assist. At the same time, there is a natural caution against jumping too suddenly at high temperatures as, above all things, central station engineers have before them all the time safety and continuity of operation. The advantages offered of cheaper machines, however, are not lightly to be turned aside, and if manuacturers can show, as it seems highly probable they can, that even new machines are working at higher temperatures than the central station engineers imagine, there is every reason for co-operation between the manufacturers and the users; always bearing in mind the ultimate consideration of cheaper electricity. On the whole, Mr. Jublin's paper met with a greater degree of acquiescence than do most Institution papers. Moreover, it did not put forward the case for higher temperatures on general grounds, but dealt in detail with the many factors which will have to be cosidered in

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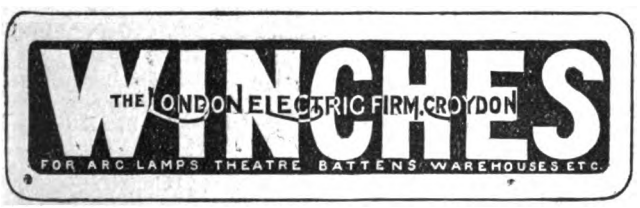
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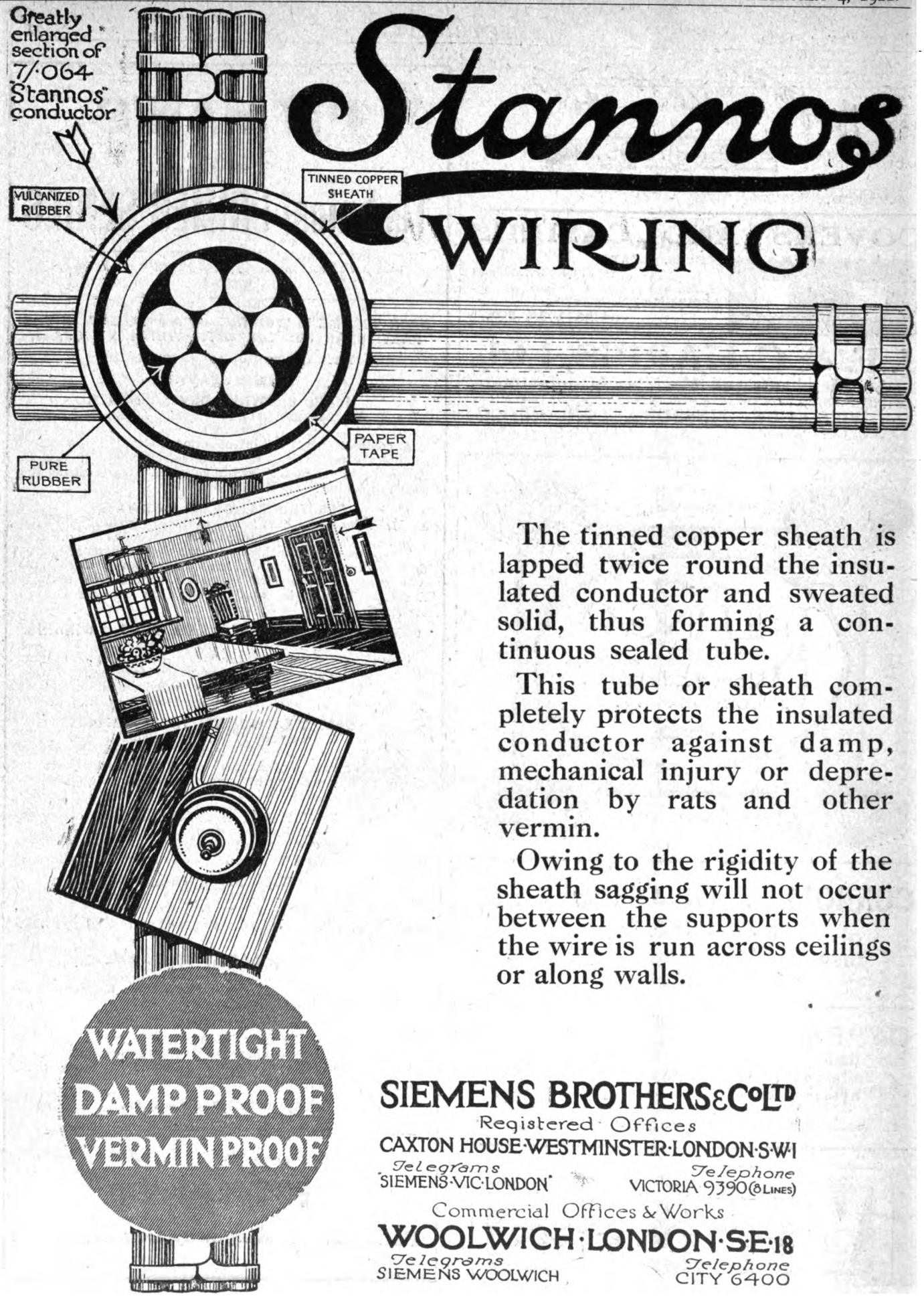
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working along these lines, and particularly as regards the nature of the insulations. It is shown, for instance, that the percentage of mica in the insulation has a direct bearing on the breakdown voltage which bars will stand after heating, and the conclusion is arrived at that mica insulations, as used in modern turbo-alternators retains its mechanical and electrical properties up to 200 deg. C.

Correspondence.

CORRECTION.

To the Editor of ELECTRICITY.

DEAR SIR,—I regret troubling you, but in the proof of article "By the Way," I let pass a serious technical slip.

In last but one par, anent meter tricksters and in reference to the cobbler, "polyphase meter" should be "single-phase meter"; and he did not reverse "one of the phases," but reversed the shunt coil.

Perhaps you would make the necessary correction, or else return proof sheet to me.—Yours faithfully, G. E. M.

[The above letter arrived too late for the correction to be made.]

ARMATURE WINDING (TESTING).

To the Editor of ELECTRICITY.

DEAR SIR,—I have read with interest the criticism of "H. C." of my article on "Armature Winding (Testing)" I regret that the whole of the points in the article do not meet with his approval. I will, however, try to make them more clear.

As you know, the article was written to meet the wishes of several readers in different parts of the country, and I believe it met the requirements of those readers. I am always willing to help your readers if I can.

The first item that does not meet with the approval of "H. C." is my term the *average electrician*. A man may be an excellent electrician for ordinary work, but he can hardly be expected to carry out special work, especially if there are no classes held in the technical schools to assist him to gain a knowledge of this subject. To substantiate this I will quote the district in which I am living as an example.

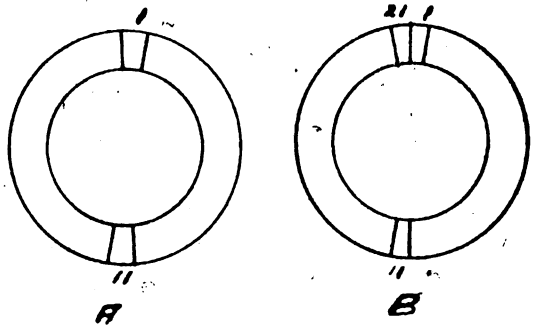
This, as you know, is a colliery district, and the electrician in the mines has more responsibility than a man working with a plant above the ground. Moreover, the class of work is much different. How many (dare I say ordinary, or average?) electricians know anything about mining signalling, telephones, coal cutters or shot-firing dynamos? Surely I am justified in saying that the *average* electrician could not carry out this work, and that an electrician who does the work is in need of some assistance, especially as in this district the subject is not taught in the technical schools.

Following the same line of reasoning, am I not justified if I presume that the ordinary, or average, electrician sometimes needs assistance when he is confronted with an armature that he has never seen before, especially if he is expected to rewind it?

When I refer to the average electrician in charge of the isolated power plant I know exactly what I am talking about. Some years ago I held the position of "Trouble Engineer" to a large company, and my duty was to get both my company and the average electrician out of trouble. Almost every plant I visited, and I was never sent to a plant unless there was something wrong, I found that the electrician was in need of assistance and advice. It is only natural. One cannot expect an electrician, no matter how clever he may be, to know *all* about a *new* plant. My use of the term *average* is because I found some electricians better than others.

Regarding joint resistances, "H. C." may not know this, but first year students in technical schools are taught all about this not very difficult subject. This being so, is it not reasonable to presume that an electrician, given the resistance of a coil in an armature, would be able to calculate the joint resistance of the total coils, no matter how they were connected up?

Referring to a lap-wound armature, if the commutator segments which are immediately opposite to each other are connected to two leads, there will be an equal number of coils on each side of the segments. This is made more clear if the enclosed diagram is considered for a moment.



Here A represents a commutator of 20 segments. If a connection is made to segments 1 and 11 there will be ten coils on each side of the connections. In other words, the resistance of the armature will be the joint resistance of two circuits, each circuit containing ten armature coils. Referring to simple figures, if the resistance of one coil is one ohm, then the resistance of the two paths in parallel will be 5 ohms.

B, in this diagram, represents a wave-wound armature of 21 segments. If the first coil is connected to segments 1 and 11, then the resistance will be found by balancing between these segments, just as the resistance of two coils is found if a test is taken between segments 1 and 21.

From this it will be seen that, given two armatures, one wave and one lap wound, it will be very easy to detect which is the lap-wound armature and which is the wave-wound one.

Now, referring to the drop test, it is true that my article did not deal with this important subject—it merely mentioned it. When one refers to the drop test it must not to be taken for granted that it is only armature winders who understand the subject. The drop test is used for many other purposes than testing armatures; thus I take it for granted that the majority of my readers know the principle of the test, which, after all, follows the principle of shunting current through an instrument, the shunt being the article being tested. An ordinary shunt ammeter makes an excellent milli-voltmeter.

Now, Sir, I think I have dealt with all the points which were raised by "H. C." and I trust he is satisfied. There is only one remark I would like to make myself which you know is true. There is no glory attached to the writing of articles for the technical Press, and all writers expect and like criticism when it is of a *healthy* nature. I have written scores of articles for the technical Press in England and America during the past few years. If I have been successful in teaching some isolated electricians to be more efficient in their job, then I consider that the purpose for which the articles were written was justified.

CYRIL SYLVESTER, A.M.I.E.E., A.M.I.Mech.E.

St. Helens.
January 18, 1921.

A CONFLICTING REPORT.

To the Editor of ELECTRICITY.

SIR,—Doubtless the attention of many electrical engineers will have been drawn to a case of a youth at Palmers Green found dead in his bath, and as reported in the papers the general impression given by the headlines and brief report is that the cause of death was, or probably was, electric shock from a portable heater.

The reports were so conflicting and the matter is of such importance that I have made inquiries, and although it is

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probably impossible to overtake the impression created in the mind of the public, I think Electrical Engineers should be put in possession of the facts so that they may answer anyone who raises this case in future.

At the first inquest the medical evidence briefly was that as a small electric heater was found in the bath after the body had been removed, the presumption was electric shock, a presumption based on no technical evidence or investigation, and apparently put forward because at that time no other cause had been found. At the adjourned inquest Dr. Spilsbury, the Home Office expert, who had in the meantime been called in, stated that the cause of death was the existence of the condition know as status lymphaticus, and he found no evidence of electric current having passed through the body. He added that this condition made sudden death possible from the slightest shock, such as fright or sudden immersion in hot or cold water. Unfortunately this use of the word "shock" which in medicine has a general meaning, was no doubt interpreted by the reporters to suggest electric shock.

No witness was able to say that the heater was in the bath before the body was lifted out, and the coroner in summing up pointed this out, and with reference to statements made at the first inquest, to burns on the body, Dr. Spilsbury stated that these were made after death, in fact in the effort to resuscitate by application of heat. Expert electrical evidence was given disproving of the theory originally put forward.

It is evident, therefore, that Dr. Spilsbury was quite clear as to the cause of death and the fact that the predisposing cause was not equally clear does not affect the issue, which is that the suggestion of death from electric shock had no existence except as an hypothesis put forward to cover ignorance of the real cause.—Yours faithfully,

Sardinia House, Sardinia Street, W.C.2.
31st January, 1921.

LLEWELLYN B. ATKINSON, M.I.E.E.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

RUDIMENTS OF ELECTRICAL ENGINEERING. By P. Kemp. 255 pp., 94 figs. (Macmillan. 6s. net.) Those of us who have essayed the task know how difficult it is to give in one small volume a readable, useful, and reasonably well-balanced survey of the rudiments of electrical engineering. The field to be covered is so enormous that there is corresponding difficulty in determining what is to be said and what left unsaid. The author of this book has succeeded very well indeed in providing a simple description and explanation of the ordinary electrical apparatus in practical use. The treatment given is non-mathematical, and the work covers such a range of subject matter and in such an interesting manner, that it should certainly "spur on those whose daily work lies in the midst of electrical apparatus," and serve as a useful introduction to books of a more advanced character.

The twenty-two chapters of the book give a surprising amount of useful information, and in all cases quite a good grounding in fundamental facts and principles. The general principles of electrical power and energy, and of magnetism, are explained. Generators, motors, primary and secondary cells are considered. Electric circuits, electricity supply and tariffs are discussed, and there are chapters on various special classes of electrical apparatus such as bells, telephones, lamps and lighting, magnetos, instruments, kinematograph applications and so forth. Other chapters deal with switchgear and motor control, and there is a brief but very useful chapter on alternating currents. The book is recommended confidently to beginners and to all those who wish for a sound and simple treatment of the subject matter indicated above.

Trade Notes.

The Consolidated Pneumatic Tool Co., Ltd., of Egyptian House, 170, Piccadilly, London, W.1., have appointed Messrs. J. A. Angus, Kaims Foundry, Strand Road, Rangoon, Burma, their agents for Burma. Messrs. Angus will handle the Company's air compressors, pneumatic and electric tools, rock drills and all the accessories connected with the use of these appliances. They will also carry a stock of machines and spare parts in order to give adequate service to users of the Company's products in Burma.

L. G. Hawkins and Co. (116, Charing Cross Road, W.C.2), have started the issue of a monthly publication called "The Link," No. 1 of which has been sent to us. Its aim is to assist in all possible ways dealers handling those productions, the sales of which are organised by the Company. As far as possible, too, it will replace the monthly price sheets. The various notes are of considerable interest and worthy of perusal by dealers and intending dealers.

The Hart Accumulator Co., Ltd. (Marshgate Lane, Stratford, E.15), have sent us a copy of their list dealing with various types of ignition accumulator sets from 2 to 6 volts. Weights, dimensions, changing rates and ignition capacity, etc., are given. Further, a new folder gives the various sizes of Hart accumulators which are suitable for replacing existing accumulators used for starting and lighting on various types of American cars.

"Hand" re-fill batteries for pocket lamps and torches and the "Hand" round model dry cell are priced in a folder issued by **R. B. Hand & Co., Ltd.** (63, High Holborn, W.C.1.).

Donovan & Coy. (47, Cornwall Street, Birmingham) have sent us a copy of their export List No. 8,120, giving prices of selected English-made accessories. The prices include packing and delivery f.o.b. British Port, but if desired c.i.f., prices can naturally be quoted.

Semi-indirect "All-glass" pendants known as Doriclite, are described, illustrated and priced in a Folder just issued by the **General Electric Co., Ltd.** (67, Queen Victoria St., E.C.4.). The object of the units described is to make possible semi-indirect lighting in lofty premises or where a white ceiling is not available. This is effected by the introduction of an upper reflector constructed of similar material to the translucent bowl, which is of "Equiluxo"—described as "the glass without glare," an onyx-like translucent medium of uniform density which transmits a perfectly diffused agreeable light, and is of ornamental appearance. The units are suitable for gas-filled lamps from 60 to 500 watts.

The G.E.C. are also issuing a sticker illustrating the "Kingsway" telephone bracket.

The second edition of "Meldrum's Magazine" has just reached us. A mixture of engineering and humour, the magazine deals essentially with the useful destruction of waste of all kinds, from dry and easily consumed waste paper, sawdust, etc., to wet spent tan, hops, and paper. The heat so generated may be employed for such purposes as boiling water, heating glue pots, heating buildings, operating drying sheds, and firing furnaces for annealing purposes. The possibilities of economically disposing of industrial waste and waste from institutions of all kinds are unlimited, and we are informed by **Meldrum's, Ltd.** (Timperley, near Manchester), that no scheme is too small, too large, or too difficult for them to deal with successfully.

A new edition of No. 3 pamphlet describing in detail the Ozonair System of Ventilation has just been issued by **Ozonair, Ltd.** (96, Victoria St., Westminster, S.W.1).

From **N. Taylor & Son** (17, Goree-Piazzas, Liverpool) comes a valuable booklet on case-hardening.

An illustrated Abridged Catalogue of Wireless and Laboratory Apparatus from the **Marconi Scientific Instrument Co., Ltd.** (21, St. Anne's Court, Dean Street, Soho, London, W.1), will appeal to all wireless amateurs and experimentalists. It deals with a selection of Variable Air Condensers, Tuners, Potentiometers, Resistances, Valve-Holders, Valves, Crystal-Holders, etc., etc.

A well designed and executed poster in black and white is being issued by the **Electrical Development Association** (Hampden House, 84, Kingsway, W.C.2), as an aid in the campaign for urging the giving of electrical apparatus such as kettles, fires, irons, table standards, vacuum cleaners, etc., as birthday presents.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 111.

I desire to equip a small test room at the works where I am employed to test meters, motor armatures, etc. Can any reader give me any details of the equipment I shall require for such a purpose? I desire to do testing as applied to a fairly large lighting and power plant. The system is 440 volts, 3-wire.—"ARMATURE."

QUESTION NO. 112.

Can any reader give me a good idea of the principles of operation of the automatic telephone system? I am told that the system is entirely automatic—that is, no operator is required even for a large exchange.—"RECEIVER."

(*Replies to Questions Nos. 111 and 112 must be received not later than February 26, 1921.*)

HYDRO-ELECTRIC POWER IN N.E. ULSTER.

One of the many urgent things which the new Ulster Government may be called on to legislate for will be a comprehensive electrical power and lighting scheme for the north-eastern part of the "Imperial Province." Before the war various schemes were in contemplation in connection with the potential power of the Bann running to waste—not only waste but actually causing enormous damage annually by tremendous floodings over its banks—but the war, and subsequently the terrible state of the country, knocked all private enterprise on the head. With the advent of a new Government and the sure and certain knowledge that Ulster can legislate for herself without the interference of the Ireland that does not wish to progress, or become other than what it is, the potential power of the Bann should come within the region of things practicable. The Bann is the outlet of the 153 square miles of water possessed by the Lough Neagh. The Lough stands 48 feet above the sea level, it receives annually about 2,000 million tons from the watershed it drains, allowing 50 per cent. for absorption, etc., and at the Falls of Coleraine drops fifteen feet over a rocky ledge. One enthusiast, who has raised quite a sensation in the Belfast Press on this subject, estimates the potential annual output of the Bann at 2,000,000,000 horse-power. The cost of transmission to Belfast—which would be the chief customer of such a project—25 miles distant—would admittedly be heavy, and very valuable fisheries would have to be bought up, about 800 families earning their livelihood in working them, whilst the Irish Society, London, is deeply interested in fisheries and water rights of the Bann.

The powerful tidal current of Strangford Lough, County Down—which rushes at a great speed through a narrow channel to the sea—instead of being only a terrible danger to navigation could be turned into electrical power to the great advantage of the locality, it is asserted, and the high tide of Larne Lough utilised in a similar manner. Certainly, N.E. Ulster has need of a power other than that given by coal. The recent Government borings near Lough Neagh—work which cost about £15,000—did not result in coal being found, though private enterprise in adjacent areas has been more successful. All the coal raised annually in Ireland would not do more than run Irish industries for a couple of weeks.

Various Items.

S.W. Midlands Electricity District.—The Electricity Commissioners have extended the time during which objections or representations may be made until March 31.

Small Dynamos for Sale.—Messrs. Green and Co., of 85c, New Oxford Street, London, W.C.1., have for sale a quantity of small dynamos. For particulars see small advertisements.

Personal.—Mr. Westgarth Forster Brown, M.I.C.E., a director of the South Wales Electrical Power Distribution Company Ltd., has been elected to the presidency of the South Wales Institute of Engineers.

Calendars.—From our contemporary, "The Managing Engineer," of 37, Walbrook, E.C.4, we have received a useful memoranda calendar pad for 1921. It is certain to be appreciated by the readers of that paper.

The Electro-Harmonic Society.—The next Concert (Ladies' Night) will be held in the Great Hall, Cannon Street Hotel, on Friday, Feb. 11, 1921, commencing at 8 p.m. Chairman, Capt. R. J. Wallis-Jones, O.B.E., T.D. Evening dress.

Mytholmroyd.—The District Council have appointed Mr. W. Emmott, Halifax, as their consulting electrical engineer, and a commitee has been deputed to open up negotiations with the Yorkshire E.P.Co. for the supply of electricity to the district.

Personal.—Mr. O. L. Record has, we understand, severed his connection with the Electrical Engineering and Equipment Co., of 109, New Oxford St., W.C.1., and for the present all communications should be addressed to him at Dacre House, Victoria Street, London, S.W.1. ('Phone: Victoria 2728).

Engineers' Club, London.—Twenty-three more names have been added to the Provisional Committee in connection with the proposed Engineers' Club in London. These include many men holding high positions in the engineering industry, and it most certainly looks as if the undertaking should start with every prospect of being a great success.

Prospective Business Overseas.—The Borough Council of Taumarunui, a rising township on the main trunk line from Wellington to Auckland (N.Z.), have recently adopted a proposal to develop electric energy from the Wanganui River, for use for power and lighting purposes. The works are estimated to cost £44,000 and a poll of the ratepayers is to be taken as soon as possible to secure powers to raise a loan for the purpose.

English Electric Journal.—The January issue contains as usual a number of excellent illustrated articles on different manufactures of the English Electric Co., Ltd., The more important articles include a description of the Willans Works, Rugby, the, "Governing of Steam Turbines," by J. P. Chittenden, "Electricity in the Tinplate Industry," by L. Rothera, and "Fuses," by H. W. Kefford. In addition there are some interesting notes on the Organisation.

Meetings.—An address on "The Position of Cost and Works Accountants in co-ordinating the aims of Capital and Labour" will be given by Mr. H. W. Allingham on Wednesday, February 9th at 7 p.m. at the Hall of the Institute of Chartered Patent Agents, Staple Inn Buildings, Holborn, W.C., and any reader who may wish for a ticket of admission can obtain one from the Secretary of the Institute of Costs and Works Accountants, 38, Grosvenor Gardens, Victoria, S.W.1.

Masonic.—At the regular meeting of the Kelvin Lodge, which was held at the Mark Masons' Hall, London, on Friday the 28th ult., the reigning master, Mr. H. Porter-Cox, presided over a gathering of ninety-eight members and visitors, including three Grand Lodge officers, namely, Messrs. Charles F. Quicke, E. J. Reid and P. P. Kipping, as well as others of Provincial and London rank, and all present enjoyed the speeches and the musical entertainment which was provided after dinner. Applications to join the Lodge are coming in steadily, and each year the support given to the great masonic charities seems to exceed that of the previous year.

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Electric Development in New Zealand.—H.M. Trade Commissioner reports that according to the "New Zealand Gazette" of Dec. 2, 1920, the ratepayers of the Wairoa Electric-power District have approved the proposal of the Wairoa Electric-power Board to borrow the sum of £100,000 for the purpose of:—(1) Erecting main transmission and feeder lines between Waikaremoana and the Borough of Wairoa, including substations and equipment (£35,000); (2) erecting subsidiary transmission lines, feeders, and sub-stations for the main transmission line to outlying districts in Wairoa County (£60,000); (3) purchase of electric motors, machinery, fittings, etc. (£5,000).

The Proposed Electrical Extensions at Woolwich.—The Borough Council having sought sanction for a loan of £230,000 for electricity extensions the Electricity Commissioners have given their formal consent and have given an immediate sanction to the B.C. borrowing £60,000 for a 5,000-kw. turbo-alternator, condensing plant, and a 33,000 volt cable. As the working of the undertaking involves a charge on the rates the Commissioners have referred the matter to the L.C.C., which body desires the B.C. to repay the debt outstanding on superseded plant and to enter into arrangements for the liquidation of any loans outstanding on plant to be superseded by reason of the proposed further extensions.

Barrow.—The T.C. have agreed to the Electrical Engineer and the Surveyor preparing a report upon the proposed utilisation of the River Leven at Backbarrow, for the development of electricity. Should Barrow require further current immediately, Messrs. Vickers, Ltd., could supply it from their new power station at Buccleuch Dock. A confidential report prepared by the treasurer, upon the financial aspect of developing the town's electrical undertakings, has been considered. It was decided to become members of the joint electricity authority for the district, the Corporation representatives to report upon developments to the Council before committing them to any schemes entailing financial obligations.

Electric Railway Construction in Norway.—The Norwegian Government has granted a concession to "A/S Akersbanerne" to construct an electric railway from Majorstuen through Taasen to Sognsvandet and from Taasen to Sagene, a suburb of Christiania. Preliminary work in connection with the levelling of the route is to be put in hand immediately. It is estimated that the rails will be required at the end of 1922 and cars in the autumn of the same year. "A/S Akersbanerne" recently applied to the Government for a further concession in respect of a prospective line from the centre of Christiania to Ostensjo, a distance of about eight kilometres. If granted, both lines will be built simultaneously, and further material will be required.

Swansea Corporation and their Electricians.—When the Electricity Committee's report came up before the Council it contained a resolution as to the men (members of the A.E.U.), being paid £5 16s. per week on the understanding that if the National Joint Council (before whom the general question of wages of fitters is still pending) gave their award higher than this figure, such higher figure shall be paid the men, but if the award was lower, then the sum of £5 10s. should still be paid them, such increase to date from the society's application to the Board. Alderman Owen took exception to the resolution and moved an amendment to the effect that the men abide by the award to be made, whichever way it went. "They can't have it both ways." Councillor Lovell characterised it as "heads I win, tails you lose." The amendment was carried.

Unique Ornaments.—A collier was charged at Tredegar for stealing a well glass, value, 2s., the property of the Markham Colliery Co., Ltd., and the prosecuting solicitor said the pilfering which was going on at the Colliery was becoming a very serious matter, and the management wished the Bench to take a serious view of the case, not only from the fact of the stealing of the glass but also from the danger to the mines. By removing the glass, defendant left two live contacts in the electrical fittings exposed, and if anyone had put a piece of metal to them it would have created a spark, and something serious might have happened, whilst if anyone had put their finger to it they might have been electrocuted. W. G. W. Elliott, the electrician, said that there were a lot of these glasses taken away, and he believed that they were used in the houses as ornaments. Defendant was ordered to pay £2.

Great Science Discovery.—Hitherto the tangible nature of the volt has apparently not been thoroughly grasped by the so-called members of the electrical profession, but we are glad to hear from a friendly reader how, a short time ago, a "rat bit a volt." He (the friend, not the rat) sent us a cutting from a provincial journal which reads as follows: "Rat Bites 500 Volts.—Death in an unusual guise has overtaken a famous rat at Derby. The rat, having gnawed its way to a duct, near the electricity stores, held up the tramways service on several occasions. Finally, it began to make a meal of the casing of a power cable, and was electrocuted with a 'shock' of 500 volts. The rat's involuntary suicide caused the cable to fuse, with consequent waste of current." Unfortunately the paragraph does not state how many volts the rat bit off, out of the 500 which formed his meal prior to his departure to ratland, and we should like to have this point cleared up. We feel certain it would be of interest to many readers. At any rate, we expect the rat's last ohm was a volt and that it won't amper his resistance.

Technical English.—Here is a report made by a lineman in India: "Fault founded nearly one mile 42, 44 and 95 on NP side. A bat was hanging. 42 was in its mouth and 44 was in its hand and body was on 95. Removed (NP added)."

Meetings.—The fourth ordinary general meeting of the Inst. E.E. (Scottish Centre) will be held at The Rooms, 207, Bath Street, Glasgow, on Tuesday, 8th inst., at 7.30 p.m. Paper: "Automatic Protective Devices for Alternating Current Systems, by A. E. McColl.

Tenders Invited.—The Postmaster-General's Department Queensland, is being asked for the supply and deliveryof switchboard apparatus and parts (Schedule No. 515). Sealed patterns of the apparatus, etc., required are available for inspection at the Offices of the High Commissioner for Australia, Australia House, Strand., W.C.2. Local representation is necessary, and the latest date for the receipt of tenders in Brisbane is the 30th March, 1921. A copy of the specification and conditions of tender may be seen by U.K. firms interested, on application to Room 59, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.——A copy of the specifications, etc., relating to a call for tenders by the Postmaster-General's Department, Perth, Western Australia, for the supply and delivery of accumulators, power board and associated apparatus (Contract No. W.A. 333), may be inspected by U.K firms interested, on application to Room 59, Department of Overseas Trade, 35, Old Queen Street, London, S.W.1., while another copy will be available for loan (in rotation) to firms in the provinces unable to arrange for inspection in London. Local representation is necessary, and the latest date for the receipt of tenders in Perth is the 29th March, 1921.

Belfast.—At a special meeting of the Corporation in committee on the 27th ult. the situation of Belfast in connection with the supplies of electricity for next winter was under consideration. It is not expected that the new harbour power station will be completed until the middle of the winter of 1922, and it is estimated that before the current from that station will be available the demand will be much greater than the existing stations could cater for. The Electricity Committee and the Corporation as a whole are anxious there should be no repetition of the series of irritating breakdowns due to failure of power which have marked the present winter. The Chairman of the Electricity Committee made a statement regarding the position of the undertaking, and submitted a resolution passed by his Committee recommending, in order to make provision for the additional plant that may be required to meet next winter's demands, that the second 6,000 kw. set, which was under order for the new harbour power station, should be installed temporarily at the auxiliary power station in the Musgrave Channel Road, subject to Messrs. Harland and Wolff, Ltd., granting the necessary facilities. The resolution was passed. It will probably be necessary to apply for sanction for a loan of £24,000 to put this decision into effect. The entire proposal is subject to the approval of the Electricity Commissioners.

The Universal Electric Heater and other Universal Appliance are illustrated and referred to in a folder (No. 660) sent us by L. G. Hawkins & Co. (116, Charing Cross Road, W.C.2.)

As usual, the first of the month has brought with it the monthly magazine of Higgs Brothers, Sand Pits, Birmingham. This contains a list of the motors which the firm can supply from stock, together with the usual valuable practical hints and tips, as well as humorous replies to correspondents by "Aunt Agatha," and various laughable paragraphs. We note with interest that the certified net sales of this magazine, after deducting returns, average ooooooo copies per month. We expect that the announcement on this subject will in due course appear in the columns of the paper which is hoping shortly to run the British Empire!

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

FRIDAY, FEBRUARY 11, 1921.

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FOUR-WIRE TELEPHONIC REPEATER SYSTEMS.

At meeting of the Institution of Post Office Electrical Engineers (London Centre) held at the Royal Society of Arts, Adelphi, W.C., on Monday, 10th January, an interesting and valuable paper by Messrs. C. Robinson, B.A., A.M.I.E.E., and R. M. Chamney, B.Sc., A.M.I.C.E., was read; the subject being "Four-wire telephonic repeater systems." As the paper will be published *in extenso* together with a full report of the discussion, in an early issue of the *P.O.E.E. Journal*, we do not propose to do more than summarise some of the main points here. Mr. J. M. G. Tresize presided.

The paper was read by Mr. Robinson. Introducing his subject he said: Four-wire telephonic repeater systems are those for which two pairs of wires are required over the whole or part of the telephone circuit. One pair is used for transmitting from the "up" station and the other from the "down" station. Since double the number of telephone pairs are required as compared with either direct or balanced repeater circuits, it is evident that four-wire systems can only be worked economically on specially designed lines using small gauge conductors. Up to the present time repeaters have been required to work on comparatively heavy gauge circuits for which four-wire systems were not suitabe for economic reasons. On this account four-wire repeater systems received little attention in this country until the year 1919. In view, however, of the post-war extension of the underground system it became necessary to carry out an investigation of the properties of this type of repeater system. The present paper gives the results of investigations and practical trials carried out by the Research and Telephone Sections of the Engineer-in-Chief's Office. A portion of the preliminary matter was read on a previous occasion before this Institute. It is, however, included here in order that the subject may be as complete as possible.

The lecturer then proceeded to explain the general principles of the four-wire system, describing (a) a simple four-wire system, (b) the Van Kesteren system, and (c) a balanced four-wire system; these matters being illustrated—as indeed the lecture was throughout—by lantern slides which will be reproduced as blocks in the full report in the *P.O.E.E. Journal*. Details of the balanced four-wire system were then given, the paper dealing with (a) terminal transformers, (b) types of repeater, (c) number and spacing of repeaters, (d) modified forms of four-wire systems, (e) phantom circuits, and (f) junction circuits.

Speaking under heading (d), the lecturer said that probably the most stable system was obtained by the use of artificial lines as extension circuits. The advantages of this system were (1) stability of balance: the balance was independent of changes due to temperature, magnetisation of coils, variation with current values, etc.; (2) the balancing arrangement was simple and accurate over the whole frequency range; (3) when two four-wire circuits were connected together it was possible to connect the two pairs forming the four-wire circuit directly to one another. The disadvantage of the system was that the total attenuation of the circuit was increased by the addition of artificial extensions. This had to be neutralised by a correspondingly greater improvement given by the repeaters. In certain cases it might be necessary to employ an additional repeater in the circuit. The extension circuits might consist of actual instead of artificial lines, the advantages being that there was an economy of pairs over the two end sections, and that the additional loss due to artificial extensions was avoided. As against this was the disadvantage that the balance was more complex and less accurate, and the system therefore not quite so stable for the same transmission efficiency.

The other sections of the paper dealt with: (4) Signalling on four-wire repeater circuits, (5) design of lines for four-wire repeater circuits, (6) results obtained, (7) comparative costs, and (8) scope of four-wire repeater systems.

Of results, the lecturer said that trials had been carried out on loaded underground circuits from 24 to 80 standard miles in length. It was found possible to reduce the S.C.E. of these circuits to at most 5 standard miles consistently with stability under any end conditions. The articulation on the shorter circuits was practically perfect. On circuits of three or four hundred miles in actual length the articulation was judged to be commercial but not so clear as that obtained on a distortionless cable.

As to costs, the lecturer said it was very difficult at the present time to give an estimate of the cost of repeater circuits covering a general case. He, however, showed curves illustrating the comparative costs of (a) direct, (b) two-wire repeater, and (c) four-wire repeater circuits for underground lines from 50 to 500 miles in length. From these it appeared that the four-wire system was more expensive than the two-wire circuit until the length of circuit exceeded four hundred miles.

As to the scope of the four-wire repeater system, the lecturer said that, generally speaking, there are two classes of circuit for which the four-wire system was especially suitable. They were (a) high efficiency circuits, *i.e.*, those which must have an equivalent of less than about ten standard miles, and (b) very long circuits, *i.e.*, those which would require more than three balanced repeaters.

An interesting discussion followed.

Mr. J. G. Hill said the fact that a further paper had been necessary after the recent one given by the same authors on telephone repeaters, showed the rapid advance on the subject. At the present time there was in view nothing short of a revolution in the means of telephonic communication, and it was necessary to constitute an underground system quite different from anything we had had before, consisting of very thin wires and associated with the relays. The work involved was stupendous, and the difficulties were greatly augmented by the fact that experiments were necessitated on a type of line we had not hitherto had. The type of loading coil we had hitherto used was not the most suitable for repeater working. The paper seemed to be so arranged as to place on record valuable work, and from that point of view was entirely successful, but from the educational point of view it left something to be desired. For instance, its authors stated it was evident that four-wire system could only be worked economically on specially designed lines using small conductors. He was afraid that to the ordinary engineer the necessity for the use of four wires for one circuit would still appear far from evident in the absence of some fuller explanation. It would be an advantage if

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there was an introduction to the paper stating why a four-wire circuit was desirable and in some cases necessary.

Mr. A. B. Hart said he agreed with Mr. Hill that the paper would be improved by the insertion of such an introduction as suggested. The paper gave the results of investigations and practical trials carried out by the research and telephone sections, and, so far as it recorded those results, he had no criticism to make; but when the authors proceeded to draw their conclusions from those investigations they, perhaps intentionally, invited criticism. The criticism he desired to offer was in regard to the amount of amplification which was to be introduced at the repeater stations on a four-wire system. The authors said: "The repeaters should be spaced in the circuit so that the input is the same for each repeater. This will be the case if the standard cable equivalent of the line between each repeater is equal to the improvement given by each, and if the two end sections have the same attenuation length. . . . In the two-station system the stations should be at a distance of orty standard miles apart, *i.e.*, thirteen standard miles from each end of the four-wire circuit." Those who were acquainted with the transmission arrangements of our trunk-line system knew that the country was divided up into zones, each zone having a main centre from which radiated the junction lines to the minor exchanges. From these again there were the wires radiating to call offices and subscribers. This system had grown up as a legacy taken over by the Department from the National Telephone Company. In the agreement between the Department and the company the latter were allowed to absorb five standard miles between a subscriber and the nearest Post Office trunk centre. In some cases the company was allowed to take nine standard miles, and it had also been agreed between the Post Office engineers and those of the National Telephone Company that commercial speech was possible over forty-six standard miles with two standard telephones on the end. He fully appreciated the conditions under which that agreement was made, also he appreciated the conditions under which the National Telephone Company had been obliged to carry on its work, and he did not think the company was to be blamed for getting as much as it could. The more attenuation the company was allowed between the subscriber and the trunk end the better it was for the company, because it could make its lines more cheaply; and when subscriber's line had been taken up to the Post Office the company had finished with it. But the result was that nowadays, when the two systems were amalgamated and a transmission system had to be worked out for the whole thing, it was found extremely difficult with the plant at the Department's disposal to get the subscriber to the zone centre in ten standard miles plus a 300 o.h.m. loop, and it was the knowledge of this fact which prompted him (Mr. Hart) to criticise the statement made by the authors of the paper as to the amplification that could be used on the repeater.

Mr. Hart then proceeded to develop his point by drawing on the blackboard to show the effect supposing two people, one at Littlehampton and the other at St. Paul's Churchyard, were trying to speak to Glasgow. His point was, he said, that under no circumstances that he could imagine could such an improvement as forty standard miles be tolerated at any repeater, taking into account the very great differences that had to be catered for at the beginning. The Research Section of the Department had made some tests for the Telephone Section some time ago on the amount of current received after twenty square miles under various conditions. A large number of tests had been made and, among other things, attention had been drawn to the fact that at twenty standard miles along the line the difference between the current received from a person speaking in a normal voice and a person speaking in a loud voice might be as much as between three and sixty micro-watts. With a variation of that degree it was an extremely difficult matter to decide what amount of amplification was possible at a repeater.

Mr. Ericcsen said that one application of the repeaters was to cases where they were in a desperate condition to get a maximum application; where you wanted not only to wipe out attenuation loss, but to gain something besides; as in the case of a four-wire circuit sandwiched in between two-wire circuits, where it might be necessary to obtain what might be called a negative gain in the centre so as to gain the desired end to end equivalent. With regard to long circuits, the authors of the paper mentioned four hundred miles as the point beyond which the four-wire repeater circuit began to be economical; but nothing was said as to how far you could go. It might be of interest to know that there would be a thousand mile circuit between New York and Chicago; on that circuit there would be something like eighteen or twenty stations. The same thing could be done here; a thousand mile circuit around London would pass through Italy.

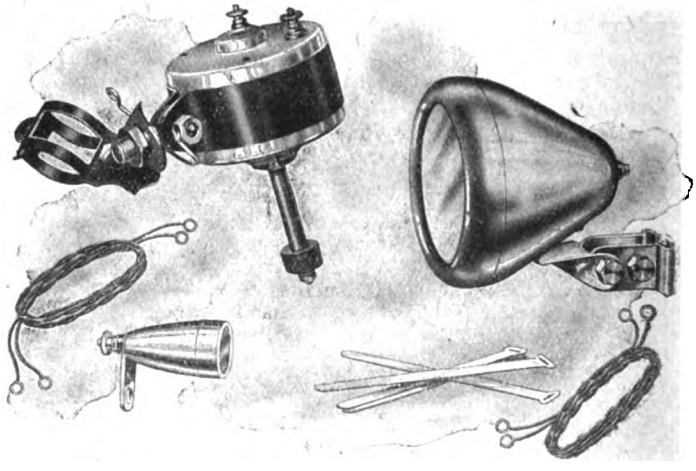
Mr. G. Greenham said that the curves showing the comparative cost of four-wire and two-wire systems did not give annual charges. He hoped when the paper was printed it might have an appendix giving details of costs, etc.

Mr. W. H. Grinstead gave an interesting account of some experiments he had made some years ago when working almost on the same question. He asked for more information as to the design and operation of the transformers used. In the circuits shown, he said, and in telephone practice generally, use was made of many transformers with direct current in the winding. That direct current magnetised the core and must to a large extent affect the constants and efficiency of the transformer. The authors of the paper said that to avoid interference the transformers must be provided with good magnetic circuits. Did that mean closed iron circuits?

Mr. Robinson replied briefly to some of the points raised and this ended the meeting.

THE ALTERNA CYCLE LIGHT.

With further reference to the note which appeared in ELECTRICITY for the 28th ult., we are now able to give some particulars of the Alterna Cycle Light Electric Lighting Set. Particularly as this especially interesting on account of the boom in cycling which has already set in and which will increase this spring. As may be seen from the illustration of component parts, the set comprises a generator, driven on the friction drive system from the front wheel of the cycle, and a head and tail lamp. Current supplied from the generator is taken *via* a two-wire circuit to both the lamps. There are several distinctive features in the Alterna system, *e.g.*, most electric cycle lighting generators



COMPONENT PARTS OF THE ALTERNA BICYCLE SET.

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are, we believe, magnetos in miniature and have a single slip-ring on which presses a carbon brush, from which one wire is taken to the lamps, the return circuit being *via* the frame and armature shaft; whereas in the system being described the generator is a miniature reproduction of the standard design for large alternators, *i.e.*, the field system revolves and the armature is the stator, this being laminated. As the field system is a permanent magnet (6-pole), there are no rubbing contacts of any kind. The design is such that the available voltage is practically constant from about 100 to 10,000 r.p.m., corresponding to a speed of progression of about 4 to 40 m.p.h. The generator is watertight and is fitted with ball-bearings. We have examined the component parts and are assured that the design is on right lines. The address of the London depôt is L. Rosengart (France) Alterna Lighting Sets, 4, Oxford Street, W.1.

LONDON'S ELECTRICITY SUPPLY PROBLEM.

The definite decision of the Electricity Commissioners to hold an enquiry into the position of electricity supply in London about June is a reminder that the long-drawn-out controversy as to the best methods of dealing with the very complex legislative problem presented by London in this matter is nearing its conclusion. The Commissioners have already called for schemes for dealing with the London and Greater London area on a comprehensive basis, which have to be submitted by March 31st, and at the moment the companies and local authorities are doing their best to arrive at an agreement which will enable them to present one complete scheme when the time comes. Whether that will be possible, however, is uncertain, not that the problem presents any great difficulties from the engineering point of view, but because the administrative aspect of it is not so easy of solution, having regard to the numerous interests involved. At the same time, it is quite conceivable that there will be differences of opinion on the engineering side which will call for the close consideration of the Commissioners, because there are signs that, due to the increasing cost of materials, and particularly cables, there is a tendency in favour of shortening the distances between the large power stations and the centre of gravity of the load. That particular point was given some prominence to when the County of London Company brought their scheme for a new power station at Barking before the Electricity Commissioners last autumn, although, by the time the Commissioners' general enquiry is held in June, it may well be that the price of copper will have fallen to such an extent as to modify this particular point of view, although labour costs are probably an even more important item.

The London County Council has definitely promised that if an agreement cannot be come to between the local authorities and companies, it alone will present a scheme to the Commissioners, in which case, of course, a fairly prolonged enquiry may be looked for, as it may well be conjectured that there will be considerable opposition on matters of detail, because, after all, even now the general principle of such a comprehensive scheme for areas as provided for under the Electricity Supply Act of 1919 is not only conceded, but regarded as an absolute essential to the rapid development of the industry. The speedy solution of the difficulties, which are to a large extent hanging up the development of electricity supply in London, is of the utmost importance, not only to the supply industry itself, but to manufacturers of electrical plant, particularly electrical apparatus of the smaller type, as to which the field of application has, as yet, hardly been touched. If, as we all hope, the co-ordination of the numerous authorities which are now supplying electricity in the London area is the only means of reducing the costs of production, then the sooner a general agreement is come to the better. The Electricity Commissioners, in the meantime, are faced with the very awkward problem of applications coming in to them from supply authorities for permission to extend their works, as obviously the necessary plant for keeping pace with the normal demand cannot be withheld because of the larger scheme, which has not yet been settled. This is another reason for expediting the matter as much as possible.

ALL ABOUT TRAMWAY BREAKDOWNS.

By H. S. B. Robinson.

To meet the requirements of modern tramway practice presents a problem, the magnitude of which can only be determined by careful consideration of the difficulties with which tramway men have to contend. Although breakdowns in connection with tramway work are numerous, it should be remembered that the efficiency of the service depends largely upon the manner in which they are handled. Consequently it is proposed to mention those of everyday occurrence and to suggest the probable causes of each, together with a practical method of overcoming the difficulty.

Cars Refuse to Start.

This is perhaps the type of breakdown that causes the greatest amount of inconvenience to passengers and dislocation to the service generally, and may be caused either by a defective trolley cable or an earthed resistance. To ascertain whether the trouble is due to a defective trolley cable it is only necessary to try the lights on the car, and if no light is obtained when switching on, the fault exists somewhere in the cable. In order to repair this damage it will be necessary to disconnect the trolley arm from the standard, when, by making a test, it will readily be found whether the injury to the cable has occurred inside the arm itself or the standard. Finally the defective cable may be easily withdrawn and replaced by a new one if too far gone for repair. If the trouble is due to the resistance, which has probably come in contact with the brake rod or other working parts of the car, the resistance must be removed from the car, and the damaged coils re-insulated with suitable insulating tape or micanite.

Cars "Blow" Automatic Switches.

This trouble occurs more often on tramway undertakings where steep gradients are unavoidable and is due to earthed or grounded armatures, open circuits in the armatures, or occasionally to defective field coils. If an "earth" cannot be discovered by burnt insulation on the surface, the armature should at once be tested for "earth" with about normal voltage. Then if the arcing to the armature core cannot be seen or heard, a few of the upper leads should be raised at different points of the cummutator, thus dividing the winding into sections. When the "earthed" section is located, the upper leads must be raised and tested for "earth" separately, then one or more coils will possibly be found defective. Should all the coils appear "earthed," it is usually the commutator that is defective. An open circuit can readily be located by pitted commutator bars, and the defective coil can be found by raising the two upper leads at each of the pitted bars and testing with a magneto between them and the other bars of the commutator. The bell will not ring when connected to the lead of the defective coil, but in the case of the other three leads it will ring when connected to at least one bar. The open circuit is probably due to the burning of one or more turns of the coil owing to a short-circuit or "earth." If this is the case, the coil must be cut out or replaced by a new one, but it is not advisable to run an armature with more than four coils cut out, unless the cut out coils are distributed fairly evenly around the armature. When cars are continually "blowing" their automatic switches when driven from one end of the car only, and there is no apparent reason for same, it will be found that the field coils are at fault, and, unless discovered in time, very often leads to something more serious in the nature of a blistered commutator or a burnt-out armature. Damp, oil, grease, etc., penetrating the insulation of the coils is the cause of the trouble.

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TROUBLE AT POINTS.

Here, again, great inconvenience may be caused to the travelling public by cars refusing to take points, which if the wheels are in good condition may be due to either the switches being improperly set over, worn tongue and pivot, or an obstruction between the tongue and casting. As modern tyres have some 2½ in. of radial thickness, it is obvious that not only the profile of the tyre will change in wearing away this amount of steel, but the time taken to get in such a condition as to cause trouble at points would be considerable. However, when re-tyring becomes necessary and the new tyres have been shrunk on to the wheel centres, they should be allowed to cool off, as owing to the stresses set up in the carbon steel when the water spray method is adopted, the tyres are naturally rendered extremely liable to breakage. The use of small studs through the rim of the wheel to fix the tyre in position is an awkward job, as it necessitates the tapping and drilling of the tyres from the underside, but the method is still employed in a few cases. It has been found that if the inside edges of the rims are chamfered and the tyres hammered down all round the chamfered part, the process is far cheaper and more satisfactory.

IRREGULAR SPEED.

This may be attributed to either a short-circuit in the motor field coils or sometimes to a short-circuited resistance, both of which will cause irregular speed of the car, and are generally due to damp. Assuming the damage to the field coils to be slight, it may only be necessary to re-insulate throughout, but should it be found upon inspection that the wire is in such a condition as to require splicing, this may be done with wire of a similar gauge, after which it should be re-taped and the whole coil well-shellaced, baked and re-insulated. With regard to short-circuited resistances it will usually be seen upon inspection that the fault is due to one or more burnt-out coils, and although it may be possible to re-insulate the old coils it is advisable to remove them and replace by new ones.

There are many other causes of tramway breakdowns, but owing to lack of space it is not possible to give a description of them in this article.

THE PROGRESS OF INDUSTRIAL RESEARCH.

In view of the criticisms which have been made of the Department for Scientific and Industrial Research recently, special interest attaches to the paper by Mr. A. Abbott, Assistant Secretary to the Department, before the Royal Society of Arts last week. The interest in the progress of industrial research associations is a far wider one than that which comes from the particular industry itself, because upon the results of research in one industry depend very largely the quality and price of articles which have to be purchased by other industries and used in turn in their manufacturing processes. To that extent industrial research is a matter of universal interest, and Mr. Abbott did well to point out possible directions in which the criticisms which have been made of the policy of the Department are founded upon a misunderstanding. In the first place, he pointed out that if British industries had realised years ago the value to themselves of scientific research the grant of a huge capital sum by Parliament would not have been necessary, because the industries would have organised research without any State grant and would have seen that the money involved was properly and efficiently spent. The purpose of the State grant is not to maintain for an indefinite period co-operative schemes of research, but to demonstrate to industry that money spent with proper care on the scientific investigation of technical problems is not a mere speculation, which may or may not yield results of value, but with reasonable care and diligence provides a safe and remunerative investment. It is well known now that the policy of the Department is to provide a capital sum of £1 for every £1 subscribed by the industry for five years up to a specified sum per annum, and the criticism has been that the results obtained should be published broadcast, for the reason that the State funds are assisting industries to improve their processes and presumably cheapen the cost of manufacture. The underlying principle, however, is that the results should be available only to the industry, and there seems no logical reason why it should be otherwise. The members of research associations, naturally, have the results placed in their hands, whilst firms in the same industry who are not members of the association can obtain the results by paying for them, and for all practical purposes this would seem very much to dispose of the critics of the Department. The up-to-date information is that there are now 23 research associations licensed by the Board of Trade, including, of course, the British Electrical and Allied Industries Research Association, and the policy which has been adopted is that these associations are investigating fundamental principles and prosecuting research only to the initial point of practical utility, the industrial firms being left to work out the methods of applying new knowledge to their own particular problems. It is quite obvious that, no matter how many research associations might be formed, individual firms, and the large firms especially, must always maintain their own research departments for the investigation of special problems, but there will always be ample work for the research associations of the kind indicated. As things stand at present, the State grant comes to an end five years after it has been commenced, by which time the industries will be expected to maintain their own research associations. Considerable progress has already been made in that direction, inasmuch as eight associations are taking steps to set up their own research institutes.

GREAT FALL IN COST OF LIVING PREDICTED.

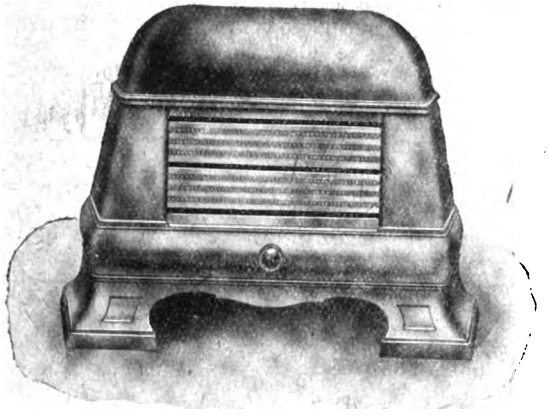
"The most prevalent evil of the day is exaggeration," writes Mr. H. G. Williams, M.Sc., M.Eng., A.M.I.C.E., in the January issue of the *Industrial League and Council Journal*, in his article on the Indisturial Situation, "and," he proceeds, "at the moment, it is devoting itself to the Unemployment Problem. If care is not exercised by the more thoughtful members of all parties, quack remedies will be applied, which will do more harm than good." There is undoubtedly a good deal of wisdom wrapped up in the last comment, as is evidenced by developments in Municipal, County and Imperial expenditures on schemes which only touch the fringe of the problem.

For months past Mr. H. G. Williams has been contributing interesting articles relative to the financial situation in this journal, and in this issue, in commenting on the variation in the index figures on the cost of living, he says :—

"These figures bear out the prediction I have been making during the last six months, ever since wholesale prices started to drop. Retail prices always follow (both up and down) about six months after wholesale prices. The latter have fallen one-third in the last six or seven months, but as wages have not fallen, but, on the contrary, risen, the same fall cannot be expected in the retail prices of finished goods. By May, 1921, however, retail prices should be about a fifth lower than they were on November 1st last, *i.e.*, the index number of the cost of living should then be about 220, implying a cost of living 120 per cent. above pre-war level. I venture to predict that by the end of this summer the level will have fallen to about double pre-war, and that thereafter world prices will fall slowly and steadily over probably a quarter of a century, when they may again reach pre-war levels."

Another interesting aspect of the *Industrial League Journal* is that it is becoming a representative organ of the Whitley Council Movement. The want of some publication dealing with the activities of all Joint Industrial Councils has been long felt, and the Industrial League and Council in thus more closely allying itself with the active side of the Whitley movement, the principles of which it promulgates, is helping materially to foster co-operation within the movement itself.

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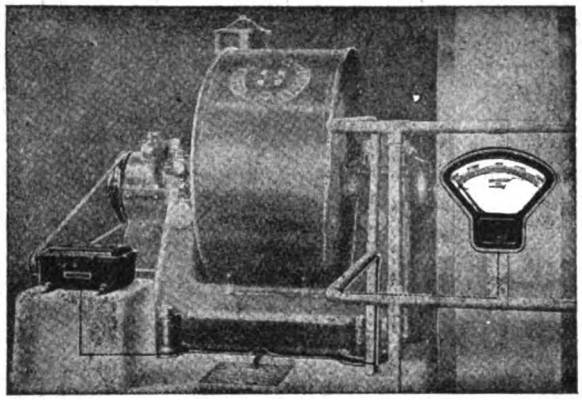
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 96-99, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

A Live Institution.

There are phases in the history of engineering and scientific institutions when they would appear to suffer from a general apathy on the part of members, resulting in a dearth of interesting or original papers. In the brief period of its existence, no such era has occurred in the life of the Association of Mining Electrical Engineers, which, originally constituted to cater for the interests of those members of the industry entrusted with the upkeep and installation of electrical gear in mines, has evidenced a very real and useful activity. The official organ, *The Mining Electrical Engineer*, which is published monthly, is invariably replete with readable papers contributed by members in various colliery districts, and the variety of the subjects dealt with, coupled with the thoroughness and critical manner in which the various authors deal with their subjects, indicate an enthusiastic and enterprising membership.

I have experienced the discussions on papers read at the meetings of this Association, and, by comparison with other learned socities, I think it would be difficult to find more critical and intensely analytical audiences than those composed of electrical colliery men. The reader of any paper must be a master of his subject and have his wits about him if he aspires to satisfy his mining critics. In this connection a recent paper by Mr. J. Marshall Bell, on "The Education of the Apprentice," read before the East of Scotland Branch in December last, is of more than passing interest, particularly having regard to the acknowledged defects in our present system of State education.

Speaking of originality in the mind of the individual, a characteristic which is sadly lacking to-day, Mr. Bell indicates this modern attempt to turn out all scholars on the same plan as probably one of the main defects of modern education. The Montessori method goes to the other extreme, being founded on the underlying idea of allowing each child to learn by doing, and more or less going, as it pleases. Mr. Bell suggests a middle course, viz., general education for most of the time, and the remainder of the educational period spent in allowing each scholar to develop, on individual lines, any capabilities that he may possess. Simplicity is strongly advocated. Certain basic subjects are essential, but let these be few, thorough, and simple in treatment. The three R's go a long way towards the general education necessary for good citizenship, which should be the minimum aim of all educational systems.

Probably the most interesting and instructive of Mr. Bell's remarks are those relating to choice of occupation, and therefore of a career for the student. He instances the need for a scientific method of selection, and also the necessity for taking into account what particular occupations are in need of recruits at the time the scholar is nearing the end of his school period. As Mr. Bell remarks, the results of school examinations give a prospective employer very little to go upon, and, on the other hand the teachers, who perhaps are judges to a certain extent of their pupils' capabilities, are not in a position to advise on the choice of an occupation when they know little or nothing of what the boy will be called upon to do when he starts to earn his living in that sphere.

Mr. Bell urges closer co-operation between employers and school authorities, and suggests that school authorities might readily develop a better system of recording a child's progress at school. Tests of physical and mental qualities would require to be made periodically, resulting in a record somewhat after this model: Boy, age 12. Physical tests—"Physique" normal, "eyesight" normal. Not easily fatigued, etc., etc. Mental tests—Observation good for objects seen out of doors; not so good for indoor objects. Poor for sounds. "Memory" visual, good; auditory poor. Rather imaginative and easily acted upon by suggestion. Interested chiefly in drawing and natural sciences. Rather weak in arithmetic. Cannot concentrate on any subject for a long period, etc., etc.

Commenting on this record, the author rules out newspaper reporter or clerk as suitable occupations, and advocates an outdoor life. The lad might be a good field geologist in the making. Certain points require strengthening, concentration for example, and his natural tastes allowed to develop. Why try to make a mathematician of him or force him to an indoor occupation which for the time being offers a high rate of wages? I have commented at some length on this phase of Mr. Bell's paper as I consider his subject one of supreme importance at the present time when industry, now in such a parlous state, is being recruited from the rising generation. His summarised findings are also well worth placing on record, and I give them below.

---

(1) That the Association consider elementary as well as technical education. (2) That the human mind must be studied to a greater extent than hitherto, and in a more scientific way, with a development of the practical applications of the science. (3) That school education should be simpler, more thorough, and more individual in application. (4) That each scholar should be encouraged to appeal more directly to Nature, to think for himself, and to develop his own particular qualities. (5) That a record should be kept of the scholar's physical and mental qualities, apart from the mere results of examinations of the present kind. (6) That each industry should consider what qualities are desirable in its would-be recruits, and that its conclusions should be made available. (7) That there should be a better means of choosing an occupation than the present haphazard one. (8) That there should be closer co-operation between employers and school authorities.

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The Psychology of Strap-Hanging.

A lady writer in the *Daily Mail* endeavours to manufacture evidence of a sex war in the present tendency on the part of most men who travel on the Tubes not to forfeit their seats unless under exceptional circumstances, such as on behalf of an elderly woman, or one burdened with a child or parcels. The writer reads into this apparent absence of chivalry on the part of travelling mankind a general resentment against the emancipation of her sex. It is nothing of the kind; men as well as women are apt to tire with the exertion of earning their daily bread, and, exasperated by the apathy of the transport authorities towards overcrowding, have cultivated the habit, undesirable as it may appear to the fair sex, of taking advantage of that which they have honestly earned and paid for—viz., reasonable comfort in travelling.

The whole thing boils down to a matter of transport inefficiency. Man was not made, nor woman either, to travel under similar conditions to inanimate goods, and, unless and until the authorities responsible for passenger travel in London and all other large centres of population awake to the necessity for providing reasonable passenger accommodation, whether on Tube, surface or other independent vehicular means, we shall always have this note of irritation and needless exhaustion of the business community on its way to and from work. From an emergency condition, overcrowding and standing in public vehicles has become an accepted condition of every-day travel, mainly due to public apathy, traded upon by transport interests. The powers interested in making money by carrying the public are not going to worry their heads so long as the public is content to be carried like cattle in trucks. Moreover, it pays better to pack humans like sardines; less coaches, trams, and other vehicles are necessary, and the running costs are reduced accordingly. It is up to the public to remedy this state of affairs by united protest and boycott if necessary.

ELEKTRON.

LONDON AND HOME COUNTIES ELECTRICITY DISTRICT.

The scheme proposed by the Conference of Local Authorities owning electricity undertakings in Greater London for the constitution of a Joint Electricity Authority under the provision of the Electricity (Supply) Act, 1919, for the London and Home Counties Electricity District is divided into six parts and four schedules. The area of the district is about 1,660 square miles, the population eight millions, and the assessable value £68,663,477. It comprises 160 local authorities and eight county councils including the L.C.C. The Conference of Local Authorities owning electricity undertakings represents, with three exceptions, the local authorities owning undertakings in the area and is working in association with a Conference of local authorities not owning undertakings in the area. So far as the engineering side is concerned, the advisers of the Conference are working in co-operation with the advisers of the L.C.C., a group of nine of the principal London electric supply companies and certain railway interests.

Part I., with Schedule II., provides for the establishment of a Joint Authority for promoting, regulating, supervising, improving the supply of, and of supplying, electrical energy in the area. It is proposed that there be 27 members appointed (1) by Authorised Undertakers:—Local Authorities within the County of London, 8, outside the County, 4; Companies, 4; (2) by Purchasing Authorities, County Councils and Local Authorities not undertakers:—L.C.C. 3, Corporation of City of London 1, Local Authorities within the County 2, outside the County 2; (3) by the Minister of Transport:—Representatives of Railway Companies, large consumers and other interests including labour 3. The appointments by Local Authority undertakers to be on a basis of one vote and an additional vote for each complete million units sold after the first million; if not undertakers the basis is 10,000 of population. Other appointments are to be made by the respective Councils, *i.e.*, the L.C.C. and the Corporation of the City of London.

Part II. enables the Joint Authority to construct and acquire generating stations, transmission lines, etc., to supply electrical energy and deal with all incidental matters.

Part III. deals with local undertakings as regards mutual working, etc., and enables the Authority to fix standards of frequency, pressure, systems of transmission and distribution, etc.

Part IV. will deal with the question of land to be acquired and works to be constructed, if necessary.

Part V. contains draft financial clauses—at present in skeleton form only, pending the report of the Financial Adviser.

Part VI. deals with incidental work.

The Schedules deal with (1) area, as provisionally delimited by the Electricity Commissioners, (2) constitution and proceedings, (3) particulars of the engineering scheme (not yet issued), (4) issue of bills and bonds.

The Chairman of the Conference is Mr. Duncan Watson, Chairman of the General Purposes Sub-Committee is Mr. C. R. Attlee, and Mr. Leslie Gordon (Town Clerk, Hammersmith) is the Hon. Secretary.

Tuesday, June 7th, has now been fixed by the Electricity Commissioners as the opening date for the inquiry, and any representations on the question must be in the hands of the Commissioners by March 31st. It will be remembered that the County of London Electricity Supply Co., Ltd., sought permission, under Section H. of the Electricity (Supply) Act, 1919, to erect at Barking a super-power station on the site scheduled to the Romford and District Electric Light Order, 1913. After the inquiry by the Electricity Commissioners last October they intimated that they would postpone giving a decision until after March 31st of this year. The County of London Co. have now deposited a Bill for the Session 1921 dealing with this matter, but the L.C.C. are opposing it on the ground that it should not be proceeded with until it is possible to form some idea of the general scheme of supply after consideration of the proposals to be submitted to the Commissioners before March 31st.

Football.—The Girls' Football Team of the Edison Swan Electric Co., Ltd., played their first away match on the 3rd inst., their opponents being a team of girls from J. Lyons & Co., Ltd. Although defeated by 5-0, the Ediswan girls were not disgraced, the general run of the play being in their favour. Future fixtures include matches with girls' teams from Eley's, G.E.C., etc.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 18th inst., at 39, Victoria Street, at 7 p.m. Social evening. Recently elected members specially invited.——Also on Friday, 25th inst., at Caxton Hall, at 8 p.m. Ordinary meeting. Honorary Members' Lecture: "Measurements of Precision in Engineering," by H. T. Davidge.——The Inst. E.E. will meet at the Inst. C.E., on Thursday, the 17th inst., at 6 p.m. Subject:—"Magnetic Susceptibility of Low Order." Lecture I., Instrumentation, by Professor E. Wilson.——The next Informal meeting of the Inst. E.E. will be held on Monday, 14th inst., at the Chartered Institute of Patent Agents, Staple Inn Buildings, Holborn, W.C., at 7 p.m. Mr. J. R. Bowie will open the discussion on "The Design of Large Power Stations."

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ELECTRICAL ENGINEERING, GRADE II.
C.G. WORK.

Solutions to Questions set at the 1920 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(Continued from page 70.)

Q. 12.—Determine the necessary cross section for each wire of a three-phase transmission line designed to convey 500 kw. over 2 miles at 6,000 volts, with an efficiency of 95 per cent. Specific resistance of copper 0.7 microhms per in. cube.

A. 12.—Since efficiency = $\frac{\text{Power at receiving end}}{\text{Power at transmitting end}}$

$$\therefore \frac{95}{100} = \frac{500}{\text{Power at transmitting end}}$$

$\therefore$ Power supplied to line = 526 k.w.

$\therefore$ Power lost in line = 526 − 500 = 26 k.w.

If the power factor be assumed to be unity, and the voltage of 6,000 be the pressure at the receiving end, and if I be the line current, then

$$500 \times 1000 = 1.73 \times I \times 6{,}000.$$

$$\therefore I = 48.2 \text{ amps.}$$

If R be the resistance of each line wire, power lost in transmission line = $3I^2R$.

$\therefore 26 \times 1{,}000 = 3 \times 48.2 \times 48.2 \times R.$

$\therefore R = 3.73$ ohms.

But $R = \frac{\text{Spec. resistance} \times \text{length of wire in inch.}}{\text{Section of wire in square inch.}}$

$$\therefore 3.73 = \frac{0.7 \times 10^{-6} \times 2 \times 1{,}760 \times 36.}{\text{Section of wire.}}$$

$\therefore$ Cross section of wire = 0.0238 sq. inch.

THE BABY PARAGON SWITCH.

A NEW 10-AMPERE D.P. DESIGN.

We have recently examined a new M.E.M. switch for 15 amps. at 250 volts and 10 amps. at 500 volts, and find it small, strong, simple and reliable. It should find wide use on cooking, heating and small power circuits as it possesses features usually only found in the larger sizes of switch. It is provided with side handle and interlocking lid, and also with a detachable gland which enables it to be used either on conduit installations or on any of the popular flexible wiring systems. That it is made on sound engineering lines may be appreciated from the fact that each pole is mounted on a separate base of best English porcelain, while the blades are assembled on a mica insulated metal bar; which method is superior to the use of a fibre bar, with its risk of distortion and poor dielectric and mechanical strength.



We understand that arrangements are being completed by the manufacturers—the Midland Electric Manufacturing Co., Ltd. (Barford Street, Birmingham)—for the production of the same pattern in T.P. and also both D.P. and T.P. combined with a specially designed small fuse of Home Office pattern. The D.P. switch and fuse combination should be very welcome to supply authorities putting in electrical services to the many housing schemes, when that good time arrives.

Finally we might add that the Baby Paragon is an excellent example of the value made possible by scientific standardised production.

UP-TO-DATE DRAPERY STORES LIGHTING.

The premises of Messrs. W. Parnell and Company, Wilton Road, Victoria, have just been provided with an excellent lighting scheme, particulars of which we are able to give by the courtesy of the management. Fig. 1 shows one of the windows, photographed at night by the light from the window reflectors only. The system adopted is a concealed trough,

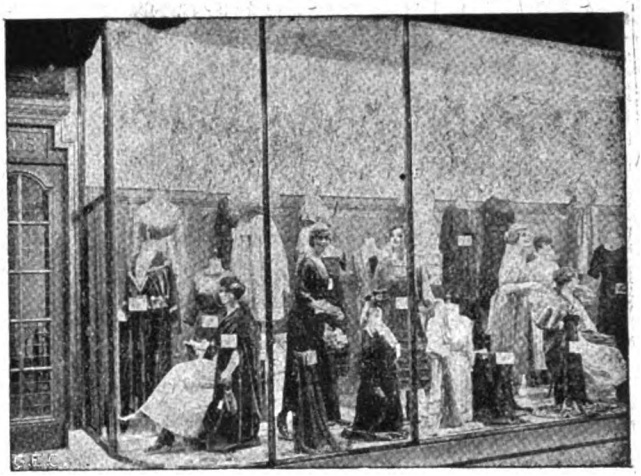


FIG. 1.—THE COSTUME WINDOW AT MESSRS. W. PARNELL AND CO'S. PREMISES TAKEN AT NIGHT.

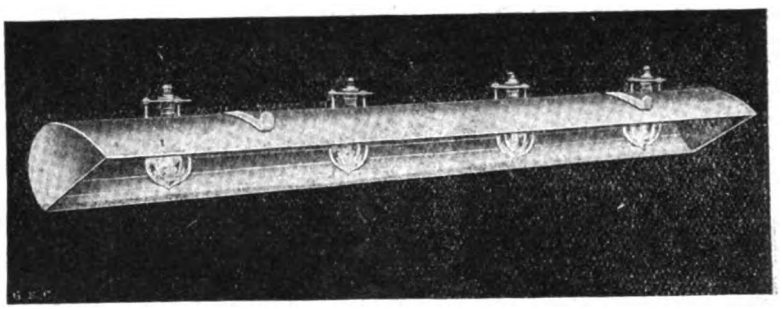


FIG. 2.—A LENGTH OF G.E.C. TROUGH REFLECTOR.

lined with opal glass strips, and fitted at intervals with 100 watt Osram gasfilled lamps. The reflectors are mounted just inside the window on the ceiling so that the lamps are well out of the normal line of vision. The lamps are wired alternately on two circuits so that the amount of light can be varied to suit the nature of the display. As will

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be seen from the photograph, the lighting is exceedingly good. The clothing exhibited is seen to the best advantage, and there is complete absence of glare from lamp filaments. Fig. 2 shows a length of trough reflector.

The showrooms are illuminated on the semi-direct principle, the fittings being simple brass bands with bowls of "Verilux" ("Celestialite") glassware. This glassware is specially suitable for the lighting of drapers' stores, as it is designed to transmit a light closely approximating to diffused daylight. It is composed of three layers: firstly, a body of clear glass; secondly, a light-diffusing coating; and thirdly, a layer of bluish glass which serves to filter out the excess of red and yellow rays—the resultant illumination is therefore a soft white light giving an almost natural daylight effect, rendering the display of coloured goods most attractive. In addition, the glassware is supplied in artistic shapes and can be combined with metal mounts to suit all styles of decorations. There is no doubt that these fittings, in conjunction with the gasfilled lamps, have contributed largely to the appearance of Messrs. Parnell's establishment, which takes rank with the best-illuminated stores in England.



FIG. 3.—THE MANTLE DEPARTMENT LIGHTED BY OSRAM (G.E.C.) GASFILLED LAMPS IN "VERILUX" ("CELESTIALITE") GLASSWARE.

The window reflector and "Verilux" pendants were manufactured by the General Electric Co., Ltd. (67, Queen Victoria Street, E.C.4), whose illuminating engineers also co-operated in the layout of the lighting scheme, and we understand their services are always at the disposal of those interested in lighting matters.

THE ELECTRICAL WHOLESALERS' FEDERATION.

On Wednesday, the 2nd inst., this young but very enterprising association held its annual general meeting at the Hotel Russell, and at the midday luncheon Mr. Albrecht, of Milburn House, Newcastle-on-Tyne, presided over a very representative gathering of members and visitors. In the course of his speech, the chairman, when proposing "The Kindred Associations," mentioned that it was the first occasion on which they had had such guests (apart from the Press), and said the members of the association wanted the guests to know more about them. He referred to the association's start in 1914, and then went on to remark that there were "good and bad factors," and it was now recognised that the good factor does fill an important part in the electrical scheme. They had duly acknowledged their shortcomings in certain directions and had started setting their house in order. Members must be genuine wholesalers, that was a most important point. Also, all having wiring interests had been eliminated. Although their numbers were not very large, they represented the best interests of the wholesale electrical trade. He then went on to welcome Mr. Atkinson among them as the secretary of the C.M.A., and alluded to the harmonious way in which the two associations had worked together. Other names coupled with the chairman's toast were Mr. J. E. Edgcome, secretary of the Electric Lamp Manufacturers' Association, and Mr. Collinson, president of the Electrical Contractors' Association. Replies were given by all three gentlemen, Mr. Atkinson laying special stress on the necessity for co-ordination and co-operation in these difficult times. Afterwards the chairman rose and, on behalf of the members, presented to Mr. Beaver a cheque for 100 guineas as an acknowledgement of the work he had done for the society, not as representing monetary value, but as an expression of the thankful feelings of the members. Mr. Beaver said a few words of thanks and rendered high praise to Mr. Albrecht for his work as chairman, after which Mr. Boden-How proposed the health of the chairman, whose reply closed the proceedings.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 111.

I desire to equip a small test room at the works where I am employed to test meters, motor armatures, etc. Can any reader give me any details of the equipment I shall require for such a purpose? I desire to do testing as applied to a fairly large lighting and power plant. The system is 440 volts, 3-wire.—"ARMATURE."

QUESTION NO. 112.

Can any reader give me a good idea of the principles of operation of the automatic telephone system? I am told that the system is entirely automatic—that is, no operator is required even for a large exchange.—"RECEIVER."

(Replies to Questions Nos. 111 and 112 must be received not later than February 26, 1921.)

Personal.—Mr. F. H. Page lately with the Crypto Electrical Co., Ltd., has joined H. W. Smith & Co., (1920) Ltd., Electrical Wire and Cable manufacturers, as representative in London.

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Volts.	Watts.	Old Price.	NEW PRICE.
100-130	40	5/-	4/-
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100-130	100	10/6	7/6
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TRADE MARK

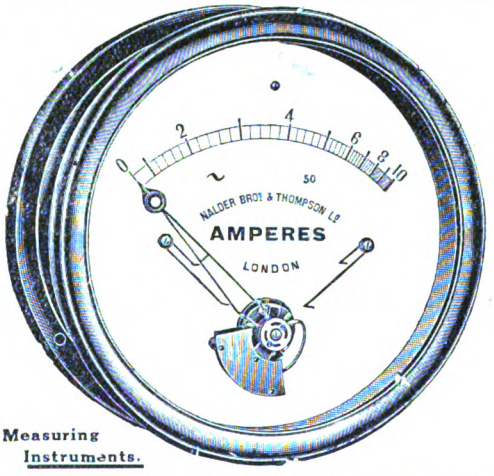
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HOUSE SERVICE CUT-OUTS.

In the Ediswan catalogue of house service cut-outs, alluded to in our recent article on junction boxes (see ELECTRICITY for January 21), is a neat pattern of combined double-pole cut-out and sealing chamber, which

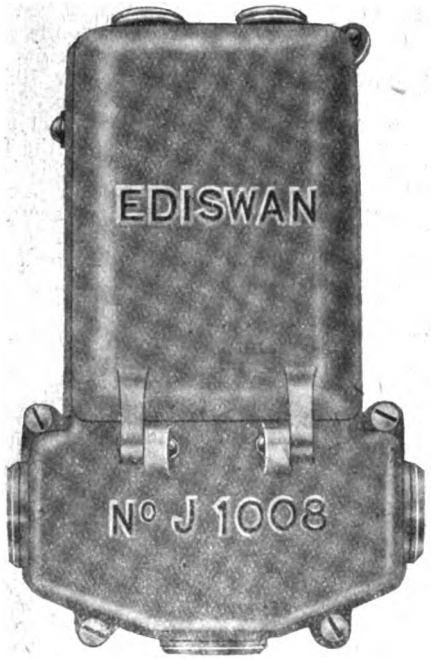


FIG. 1.—DOUBLE-POLE HOUSE SERVICE CUT-OUT WITH SEALING CHAMBER (CLOSED).

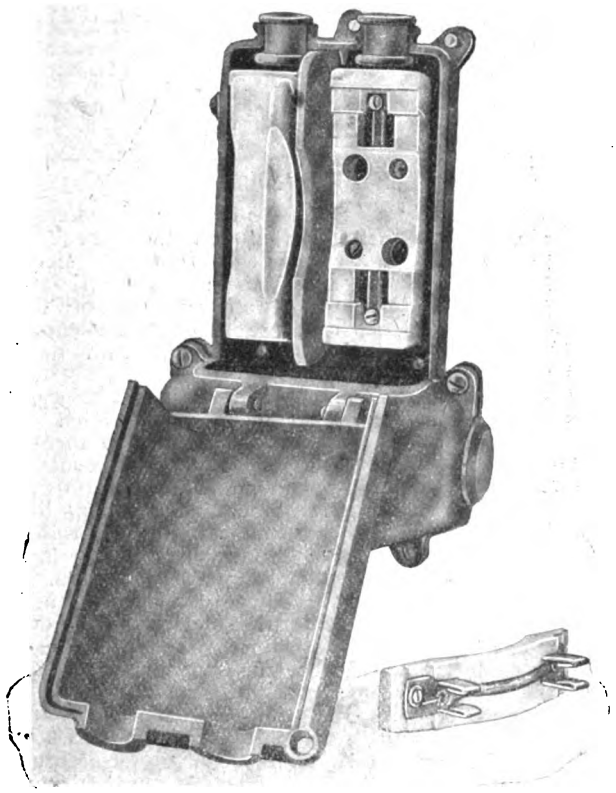


FIG. 2.—DOUBLE-POLE HOUSE SERVICE CUT-OUT WITH SEALING CHAMBER (OPEN).

should entirely remove the prejudice against placing the fuses of both poles in one case. As is seen by the illustrations (Figs. 1 and 2) the cover opens downwards. The fuses are of the Ediswan Home Office pattern, separated by an insulating fillet, and accidental short-circuiting or earthing is virtually impossible. The cable can be led in at the bottom or either side, as three blank bushes are provided. A similar design is adopted for the triple-pole cut-out, two patterns being made, one with three fuses for three-phase services, and the other with a link instead of a fuse in the middle for three-wire D.C. services.

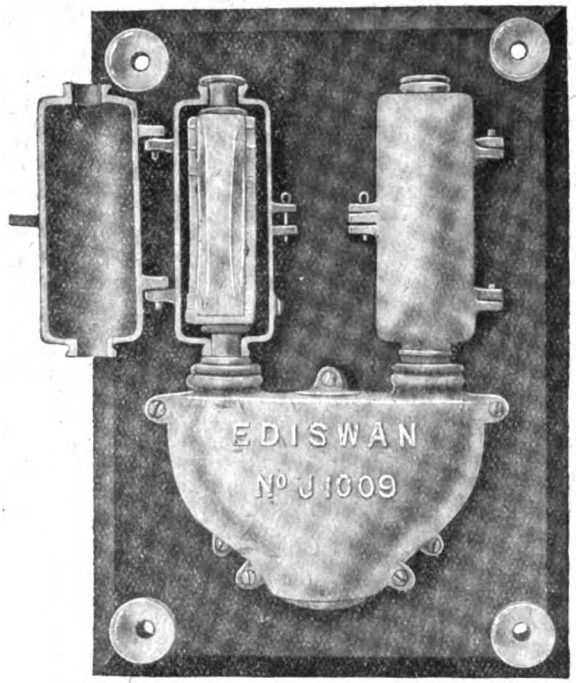


FIG. 3.—SERVICE FUSE BOARD WITH SINGLE-POLE FUSES AND SEALING CHAMBER.

For those who still prefer to use single-pole fuses a well-fitting and substantial sealing chamber (shown in Fig. 3) has been brought out. In this there is a separate bush for each pole (instead of the usual open top in which the surface of the filling compound is left exposed as a trap for dust, odd ends of wire, etc.), and attention has been paid to a proper fit between the two halves. Iron-clad house service switches, single-pole Home Office pattern cut-outs, and house service panel boards are also included in this list.

I.E.E. Annual Dinner and Reunion.—The annual dinner and re-union of the Institution will be held at the Hotel Cecil, Strand, W.C., on Thursday, March 3, 1921, under the presidency of Mr. Ll. B. Atkinson, supported by the Council. It is particularly requested that early application for tickets be made upon the form sent to all members.

Forthcoming Book.—A history of the Metropolitan Railway will shortly be published. It has been prepared with the assistance of the late Judge Sir Lumley Smith, the Metropolitan Ry. Co. Ltd., the London City Solicitor, and others. It will run to about 400 pages, and is illustrated with many old and contemporaneous portraits, engravings, plans, etc., obtained from the Library of the House of Lords, the House of Commons, the Guildhall, and from other sources. It is the first History of the first Subterranean Railway, and has been carefully revised by the Right Hon. Lord Aberconway, present Chairman of the Company.

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AUTOMATIC TELEPHONY.

(*Continued from page* 791, Vol. xxxiv.)

SIEMENS' SYSTEM.

This is a modified Strowger system working on the same principle but with a number of distinctions in the apparatus employed.

The dial switch uses a three-leaved fibre cam which normally keeps closed two springs which tend to open. As the dial goes back to normal the gaps in the cam allow the contacts to open five times if the number dialled was 5 and so on. The dial makes nearly one quarter of a revolution before the interruptions commence; this provides a margin of safety and gives the exchange apparatus time to operate even when the subscriber dials unreasonably rapidly.

The preselector or line switch is of the rotary type. It has three sets of radial wipers 120 degrees apart, one set of which is always in a bank of twelve contacts extending over about one-third of a circle. When a subscriber calls up, his preselector rotates until the wipers rest on a vacant selector trunk, the rotation being effected by a ratchet and pawl mechanism driven by interrupted currents from the interrupter which supplies the selector. The frequency of the impulses is 50 per sec. for preselectors and 25 per sec. for selectors. A motor interrupter provides this current, but during the night this machine is stopped until a subscriber calls up, whereupon it is started automatically for 2 mins.

Each preselector is self-contained. The four rows of contacts in the bank are staggered slightly and this simplifies connections by making it possible to run a piano wire multiple up the back of the bank. All relays operating with the selectors and connectors are mounted in a separate bank, only the operating magnets being incorporated with the apparatus. The side switch is replaced by relays which perform the same functions.

CLASS II.—THE LORIMER SYSTEM.

This system, which was the forerunner of the modern power worked exchange, is now practically obsolete, but there are a few G.P.O. exchanges on this system. The equipment was made in 100-line units, any number of which can be coupled together.

The calling device is not a dial, but has four levers working in slots by the side of which are numbers. The levers are set against the numbers required and a handle is turned to wind up a spring, which is subsequently released by the exchange apparatus and then sends the necessary impulses as it returns to normal.

The exchange switches are cylindrical, a central shaft carrying radial wipers. This shaft is clutched when desired to a continuously revolving power shaft. When the subscriber lifts his receiver, a primary connector rotates and finds his line. An impulse is then sent along the line which releases the spring wound up by the subscriber. The disconnections then complete the call via interconnectors and final connectors. A *pilot switch* directs the impulses to the proper apparatus. On the completion of a call, all switches rotate forwards to their normal positions.

THE WESTERN ELECTRIC SYSTEM.

Power working is employed in this system; this is more expensive than operation on the Strowger principle, but the working is unaffected by battery fluctuations. Each line switch is a 200-line unit and this reduces the trunking required. There are other features in the system which reduce the amount of apparatus required. A translator is required to convert the subscriber's impulses into impulses suitable for the non-decimal system.

The calling device is of the dial type but uses a cam with a number of projectors which, as the dial returns to normal, operate a small insulated trigger which disconnects two switches. In winding up, the trigger does not operate the springs.

When the subscriber calls up, a set of line finders rotates until the calling line is found. A *secondary line finder* then extends the line to an idle selector, whereupon a free *register* is brought into operation and a humming tone is sent to the subscriber as a signal that he may commence dialling. The calling impulses are received by the register which allows the selector to operate under its control and find the required line.

The sequence switch which controls the various mechanisms in the proper order is a rotary relay consisting of a central shaft which carries a series of ebonite cams acting on sets of springs so as to bring various circuits into operation at the proper moment. Motion is derived by clutching magnetically on to a revolving shaft which carries a flexible iron-rimmed disc of German silver normally just clear of an iron disc on the switch shaft. Round the face of the switch shaft is a coil of wire, and when this is energised the rim of the flexible disc is attracted magnetically, and a friction drive is provided for the switch shaft.

A modified and less expensive form of sequence switch has recently been introduced and is illustrated in Fig. 3.

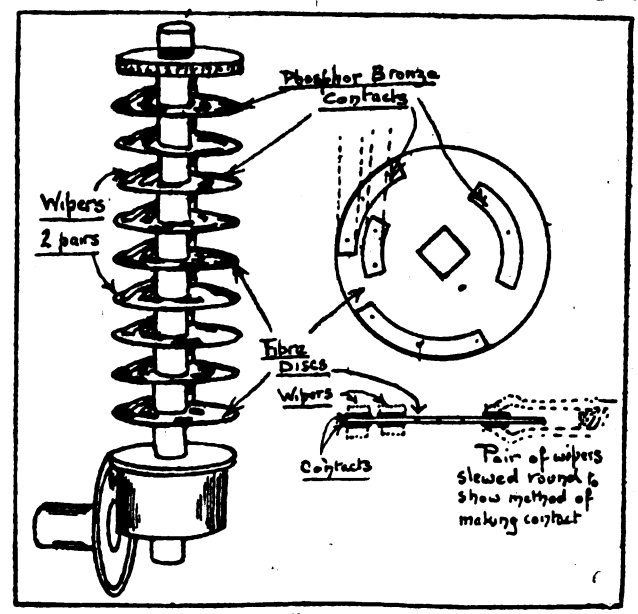


FIG. 3.

The fibre discs carry self-cleaning phosphor bronze contacts. In certain positions the circuit through the pairs of phosphor bronze springs is completed through the metallic segments which are connected together; at other times, the phosphor bronze springs are kept apart by the fibre disc.

Each selector has one of these sequence switches and others come into operation in connection with the line finders and registers.

The line finder consists of three sets of brushes, 120 degrees apart but not in the same plane. Each brush moves over a bank of twenty contacts, and the three sets are wired together so that any one of the sixty contacts in the bank may be tapped by one or other of the brushes in the course of a complete revolution. The calling line is found through one of its test contacts which is raised to a potential of 36 volts by the subscribers' line relay. A brake magnet prevents overshooting of the brushes.

The preliminary and final selectors each consist of a shaft carrying ten sets of three brushes which sweep over a semi-circular bank of twenty contacts. The brushes do not touch the contacts normally but one particular set is tripped by a *brush selector* which consists of a spindle carrying ten spokes arranged in a spiral from top to bottom. One of the spokes, depending on the number of impulses sent, catches a trigger and releases the required set of brushes. The brushes rotate until an idle trunk is found, this being determined by a battery potential of 36 volts on the test contact. When the connection is clear the brushes complete the revolution, the tripped set being then restored to position by a roller.

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A special ribbon cable is used in wiring the selector banks. A number of wires are woven side by side into a silk or cotton ribbon, the insulation being removed at definite intervals at spots which lie diagonally across the cable. The backs of the selector contacts terminate in clips which are pushed over the appropriate bare points on the cable and soldered in position.

The registers are somewhat similar to the sequence switches, and their use practically eliminates lost calls, because the register stores the impulses when no selector is vacant, and, if the subscriber does not replace his receiver in the meantime, the register will take up the call directly a selector is free.

There is one register for each digit, and the trains of impulses sent by the subscriber are complementary to the number which he dials. As the impulses come in, the corresponding registers move part of a revolution. Switching from one register to the next, after any train of impulses, is accomplished by the last impulse which is about four times as long as the others. This operates on a sequence switch which is governed by a slow-acting relay. A vacant selector having been found, the brush tripping spindle begins to rotate, and as it passes through each position it sends an impulse to the register which moves round one step. The two mechanisms rotate together until the register has completed its revolution, when the circuit for the trip spindle is broken and both mechanisms stop. The selector brushes then revolve and find an idle connector. The brush spindle of this is set under the control of the tens register and the brushes again revolve; an impulse is then sent to the unit register for every contact passed over so that the brushes are stopped in the required position.

As regards the *translation of impulses*, the 0 to 9 system of numbering is used in the W.E. system, *i.e.*, a 2,000-line trunking scheme is divided into groups, viz., 0000-0999 and 1,000-1,999 (see Fig. 4). In such a case each 1,000 group

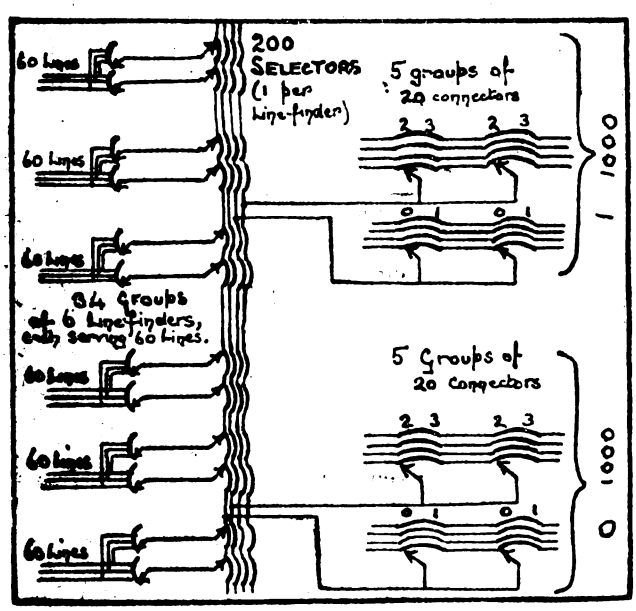


FIG. 4.

is sub-divided into five 200-line units, each served by twenty connectors multiplied together (since each connector serves 200 lines). The selector levels—twenty contacts per level—each serve one 200-line group, each contact in the level leading to a connector. The first five levels in the selector serve the five 200-line units in the "0" thousand, the remaining five serving the "1" thousand. Consider now the number 1334. The number being in the "1" thousand will be in the top five levels of the selector. The 1000 register is arranged to pull up a relay for all odd digits. The subscriber then dials 3. This sets the 100's register and, also being odd, pulls up a second repeating relay. The brush spindle on the selector now commences to rotate, sending an impulse at every step. The register skips round two steps per impulse, and so will complete its revolution in two stages. The first repeating relay being up, however, the circuit is not broken and the register makes another revolution. This results in the 7th set of brushes (2 and 5) being tripped and the selector brushes now rotate and find an idle connector in this level, which is wired to the 12 and 13 group.

(To be continued.)

"100%" EFFICIENCY EXHIBITION.

The "100%" Efficiency Exhibition at Olympia, promoted by the *Daily Mail*, was opened by Sir Robert Horne yesterday, the 10th inst., and will remain open until the 26th. During this period all interested in business and manufacture can hardly fail to obtain ideas helpful in the conduct of the operations they are engaged in, at least that is our impression from our first visit to the 200 separate stands. Every inch of space is booked up, and the exhibits are of a varied nature,, those of electrical interest covering equipment from the "Rawlplug" to an automatic electrical arc welding equipment shown in operation by the B.T.H. Company, who, by the way, have a most attractive stand (No. 52), reminiscent of a Greek temple. The Company's products from turbo-generators and motors, electrical gear for railways and tramways, and electrical rivet heaters down to lamps and X-ray apparatus, are all represented by actual samples, models, or drawings and photographs.

Electrical heating apparatus is shown by C. R. Belling and Company, on whose stand may be inspected, besides the original and well-tried designs, at least three new designs, with entirely new arrangements for the elements —to be referred to more fully later—which would appear to be at least quite as efficient as the pioneer Belling designs.

Telephones, Marconi Wireless, high speed telegraphy, small lighting sets, etc., are on view at various stands, while some of the technical colleges have noteworthy exhibits. Ex-Service men may be seen working at 48 different trades, and the B.O.T., Ministry of Labour, Ministry of Health, the Hospitals, &c., compel attention. At intervals, when the band is not playing, music is rendered by the Stentorphone—a device using compressed air to give greatly increased volume to the sounds derived from an ordinary gramophone record.

Trade Notes.

A special offer of electric light fittings and accessories at reduced prices is being made to the Trade during this month by the **General Electric Co., Ltd.** (67, Queen Victoria Street, E.C.4). Some bowl and sphere pendants, and vitreous enamelled steel reflectors and lanterns are among the items listed in pamphlet F 2480, in which we also notice table standards, silk shades, wood blocks, counter-weights and other items. Another leaflet from the **G.E.C.** deals with Benjamin R.L.M. standard dispersive reflectors for use with vacuum and gas-filled type lamps of all sizes. The lamp filament is shielded from direct view so as to prevent glare.

The Midland Electric Manufacturing Co., Ltd. (Barford Street, Birmingham), have just published a booklet entitled, "The M.E.M. Message." It gives a description of the Company's methods in the design and manufacture of ironclad switch and fuse gear. It is clamed that these methods are unique in the electrical industry, in that, although only a small range of ironclad switch and fuse gear is made, it fulfils practically every need in lighting and power installations, while the designs are made on standardised and mass production methods. The booklet is illustrated with photographs of the Company's works, offices, and productions. Copies will be sent on application.

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Various Items.

Manchester.—£100,000 is to be spent on mains extensions

Darwen.—The Electricity Commissioners have sanctioned a loan of £11,674 for the local electricity undertaking.

West Bromwich.—Application is to be made to the Electricity Commissioners for permission to borrow £67,000 for additional plant.

Belfast—The Electricity Commissioners are to be asked to sanction a further loan of £24,000 in connection with urgent extensions.

Chorley Hospital.—Leyland Motors, Ltd., have presented Chorley Hospital with a complete electric lighting and power set, value £350, to be used in connection with X-ray work.

Todmorden.—The Corporation's application to borrow £31,000 for new mains and plant, in connection with the bulk supply by the Yorkshire Electric Power Company, has been sanctioned by the Commissioners.

Meetings.—The next monthly meeting of the Birmingham and District Electric Club, will be held at the Grand Hotel, Colmore Row, on Saturday, February 12, at 7.0 p.m. Paper: "Reminiscences of the Test Bed," by Mr. C. J. A. McDonald (Member).

Rethymo (Crete).—Tenders are required by March 20 for providing the town of Rethymo in Crete with electric light and power. A booklet (in modern Greek) giving the conditions of tender, together with a summary translation and a plan of Rethymo, can be seen in Room 48, Dept. of Overseas Trade, 35, Old Queen Street, S.W.1, up till February 22.

Tenders Accepted.—The Director of Army Contracts has accepted the tender of English Electric & Siemens Supplies, Limited, for the supply of Metal Filament Lamps (Vacuum and Gasfilled Types) covering approximately 100,000 lamps. The Company have also secured a contract from the London County Council for 100,000 Metal Filament Electric Lamps.

The Faraday House Journal.—Vol. ix., No. 2, contains among other items an article by E. S. Ritter, on the accurate measurement of insulation resistance of house wiring by means of the "Megger" or a battery and galvanometer. A brief description of the Peebles—La Cour Motor-Converter is also contributed, whilst the doings of "Old Faradians" are chronicled as usual.

Blackburn.—The T.C. are applying to the Electricity Commissioners for sanction to extensions of the new generating station at Whitebirk, costing £850,000, by the provision of a second generator and ancillary plant and buildings.——Difficulties have been experienced in maintaining the standard pressure in the borough owing to the overloading of the old generating station in Jubilee Street.

Salford.—The Council has decided to borrow £750,000, of which £75,000 is required by the Electricity Department. The Labour Members regarded the period for repayment (20 to 60 years) as too short, and the rate of interest (6 per cent.) too high, and suggested that the Government should provide the money in the same way that they controlled and provided material during the war.

Burnley.—A decision reached by the Tramways Committee to reduce wages of fitters by 6d. per hour recalls the tramless Sundays experienced some months ago. The engineers applied for an increase of 6d. per hour. Pending a settlement an embargo was placed on overtime work. The embargo has now been withdrawn, and the Committee consider they are within their rights in withdrawing the 6d. increase.

Bolton.—The Tramways Manager reports that the electric current required for lighting is still taken from the metal wires of the tramways, and the charge made entails a loss on the department. Attention was called to a resolution that the current required for street lighting be taken direct from the main and not from the tramway wires. The charge for current was increased to £3 10s. per lamp per annum, and it was decided to ask for a discontinuance of the present system.

Modern Electrical Theory.—It is announced by the Cambridge University Press that in order to keep Dr. N. R. Campbell's book, "Modern Electrical Theory," abreast of the times, monographs edited by Dr. Campbell, each corresponding roughly to a chapter of the book, are being prepared and will, it is hoped, be published next October. It would seem that such a scheme, for a subject which is so important and in which fresh contributions to our knowledge are continually being made, has great possibilities.

Yorkshire E.P. Co.—The net profit for the year ended Dec. 31 last, after payment of interest, etc., and including the balance brought forward of £17,596 is £82,336. After payment of the 6 per cent. dividend on the cumulative pref. shares, a total dividend of 8 per cent. per annum is being paid on the ordinary shares, leaving £15,000 to be added to the general reserve fund, which will stand at £89,000, and a balance of £20,939 is to be carried forward. The Company has therefore had a very successful year. Out of 62 authorised distributors in the Company's area, 40 are taking, or have agreed to take, a bulk supply, and other negotiations are proceeding.

Foreign Catalogues.—An index of Foreign Trade Catalogues available in the B.O.T. Dept. of Overseas Trade contains references to 15,000 catalogues of German, Austrian, U.S.A., Italian, Belgian, Canadian, Swiss, Danish, French, Japanese, Polish, Swedish, Norwegian, Portuguese, Spanish and Finnish firms. They may be examined by U.K. manufacturers in the Library of the Foreign Samples Section, at 7-11, Old Bailey, E.C.4, or copies will be sent out on loan to manufacturers in the provinces who may desire to inspect them. During the year 1920, 6,482 catalogues were borrowed by 506 firms, the total number borrowed since the inauguration of the library being 28,000. It is hoped that the facilities provided by this library will be fully utilised by manufacturing firms in the United Kingdom. The Foreign Sample Exhibition is always open.

Electricity and Housing Problems.—A valuable contribution to the literature now available to promote a proper appreciation of the way in which electricity may be utilised for heating, cooking, lighting and other domestic applications, is made by the appearance of a pamphlet entitled "The Power behind the Home," issued by the Electrical Development Association (Great Britain and Ireland). Illustrations are given of (1) the artisan dwellings recently erected at Billingham, Stockton-on-Tees, by the Newcastle-on-Tyne Electrical Supply Co., and fitted for electric lighting, heating, and cooking; (2) the houses built by the Boro' Council of Hammersmith, and somewhat similarly fitted. Committees or persons interested in Housing should not fail to study the pamphlet in question, which may be obtained from the E. D. A. Offices, Hampden House, 84, Kingsway, W.C.2.

Electricity Supply in Hereford.—Mr. Dymond, the chairman of the Hereford Electricity Committee, has formulated a scheme for providing electric current throughout the County of Hereford, and for a part of Gloucestershire, and so far has been very successful in getting the sympathy of the authorities. The City Council have already received the sanction of the Electricity Commissioners to supply a number of parishes, and the Treasury are prepared to grant the Corporation £19,857 for extending their supply to Leominster, Kington and Wesbley areas. Since the scheme has been put forward, a newly elected member of the Council took exception owing to the big financial risk involved, but Mr. Dymond assured that body that he had seldom come across a financial proposition that had less element of danger in it than that. In all seriousness he would state, that if the Council desired to get rid of the liability, and offered him the undertaking to buy, he would very soon be able to come along with the necessary money to pay for it from the electric manufacturing trade, who would be only too pleased to buy it at its book value as it stood. The opposition to the scheme was eventually withdrawn.



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THEY ARE ABSOLUTELY THE BEST.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

FRIDAY, FEBRUARY 18, 1921.

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ELECTRONS.

By Sir William Bragg, K.B.E., F.R.S.

The 12th Kelvin Lecture, recently delivered before the Inst.E.E., was on the subject of electrons, and as the lecturer, Sir Wm. Bragg, explained most clearly the exact state of our knowledge and the bearing of present investigations leading to an appreciation of the problems of radiation and material structure, we shall reproduce the lecture almost in full.

In recent years the results of experimental research on the properties of electrons have accumulated with startling rapidity. As knowledge grows, the importance of the part played by the electron in the mechanics of the world becomes ever clearer. There are all the right signs that progress is being made along a road that really leads somewhere; we are continually finding that, through some electron action, phenomena are linked together between which we had hitherto seen no connection. Precision is given to our views: we find ourselves able to express, quantitatively and with confidence, laws and relations which have been matters of vague surmise. Every experiment that is finished suggests others that are promising. The whole world of experimental physics is full of new life, and of the consciousness that after a period of hesitation the tide of discovery is sweeping on again. I hope I may be allowed to claim that when an advance is made in the realm of physics all other natural sciences feel the impulse sooner or later.

It helps to a right appreciation of the position as regards the electron if we observe its strong resemblance to the older state of things when first the atomic theory of matter was clearly defined. Just as chemistry has grown and prospered on its recognition of the unit of matter, so electrical science has already begun a new life, and to all seeming a most vigorous one, based on the understanding of Nature's unit of electricity. There are many different atoms of matter, nearly a hundred are distinguishable by their different chemical reaction: but the number of different kinds of electrical atoms is very much more limited. We are clear as to the existence of one, the electron, Nature's unit of negative electricity. We suppose that there is a definite positive counterpart, but our ideas about it are much less precise. We seem to get along very well at present without any intimate knowledge of the positive—or, perhaps, we should say positives: for present purposes the negative unit is that which gives definition to our work.

If the chemist has found so much profit in his recognition of the fact that Nature has just so many ways, and no more, of doing up parcels of matter, the electrician will surely gain in the same way, when he grasps the fact that electricity is not merely measurable in quantity, but that there is already a unit of Nature's choice, possibly no more than one unit. We may say with justice that the most wonderful advances in modern physics are the regard for our appreciation of this truth, and we may hope with equal justice that we are yet far from reaping the full benefit.

The first suggestion of the atomic character of electric charge came, it is well known, from observation of the laws of electrolysis. Since the movement of atoms or atom clusters or ions across the electrolytic cell was accompanied by a simultaneous transfer of electricity, in which each ion, of whatever nature, bore always the same charge, or at least a simple multiple of it, there was a clear indication that this division of electricity into parcels of constant magnitude implied the existence of some natural unit charge. No progress, however, was made, or could be made, so long as the charge could only be observed as an attachment to an ion: it was not even clear that it could ever have a separate existence. In the long series of researches which finally led to the isolation of the electron and the determination of its properties, there were certain that marked definite stages in the forward movement. Crookes examined the electric discharge in bulbs exhausted to a high degree by the new air pumps which he had succeeded in making; and he observed the so-called cathode rays, streaming away from the negative electrode. He showed that they possessed the properties to be expected from a stream of particles projected across the bulb, and carrying negative electricity with them; for, on the one hand, they could heat up bodies on which they fell, and, on the other, they were deflected in crossing a magnetic field. Crookes spoke of a fourth state of matter, and defended his view against the opposing hypothesis, held largely on the Continent, that the stream consisted of electromagnetic waves in some form or other. Hertz showed that the rays could pass through thin sheets of matter such as aluminium leaf, and Lenard took advantage of this to coax them outside the bulb and display their effects in the air outside.

In the later years of the last century came the great experiments of Wiechert, Thomson, and many other well-known observers who weighed the electron and measured its charge, and showed that there was only the one electron, though it was to be found everywhere and in every body. Since then, the measurements of these quantities have been repeated many times with increasing skill and understanding. They have reached their present high-water mark perhaps in the experiment of Millikan at Chicago, who gives us the value of the charge in electromagnetic units $e = 1.591 \times 10^{-20}$, the mass being $.0903 \times 10^{-27}$ gramme, or 1/1 830 of the mass of the hydrogen atom.

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So we arrive finally at an accurate comparison of these unique and fundamental units of Nature with the units which we ourselves have chosen for our convenience, and without, of course, any relation to the other. We infer from experiments, such as those of Kaufmann and Bucherer, that the energy of the moving electron may be considered to exist wholly in the form of electromagnetic energy such as is necessarily present when an electrical charge is in motion; and that its mass is in this way perfectly accounted for. But this conclusion sets a limit to the size of the electron, and we must assume that its radius, if its form is spherical, is not more than 10^{-13} cm. or about a hundred-thousandth of the radius of any atom.

Why, we may well ask, have these measurements of charge and mass never been made before? The electron is everywhere: the transfer of electricity from place to place consists always in the transfer of electrons. The electrical current is a hurrying stream of electrons: all our electrical machinery concerns itself with setting these in motion, of giving them energy, and again withdrawing it. In the processes of electrolysis, the electrons are handed to and fro. Everywhere they fill the stage. Why have we not noticed hitherto their qualities, which so far can be expressed so simply?

The answer is that we have never, until recently, been able to make them move fast enough in spaces sufficiently empty of air or other gases. It is only when an electron has a sufficient speed that it can escape absorption in the atoms which it must be continually meeting. Unless an electron has a speed exceeding about a three-hundredth of the velocity of light, that is to say, such a speed as it acquires in falling through a potential of a few volts, it sticks to the next atom it runs up against: even with ten times that speed it can only move a fraction of a millimetre through air at ordinary pressure before it loses its velocity and, therefore, its power of going through the atoms. When Crookes first saw the cathode-ray stream in full course, it was because he had reduced the number of gas molecules in his bulb to such an extent that an electron could fly in a straight line from end to end of the bulb without going through more than a hundred atoms or so, and the induction coil had given it quite enough speed to do that without turning out of its course; no matter what sort of atoms they were. Incidentally, since atoms can be traversed in this way, we naturally think of an atom as a very empty affair.

Electrons flying still faster than in the discharge tube are found to constitute a part of the radiation from radioactive substances. Some of the β-rays have velocities nearly equal to that of light, and can pass through millions of atoms before their energy is spent. In open air a β-ray may have a course of metres in length, though it is generally broken, by encounters with traversed atoms, into a path full of corners and irregularities.

It is speed which gives separate existence to the moving electron: and speed which also betrays its presence to us. For, on its way, the electron here and there chips away another electron from an atom which it is crossing and leaves behind it a separation of electricities which may subsequently influence chemical action, as in the case of the phorphorescent screen or photographic plate, or provide a current for the ionisation chamber. We do not know exactly how this removal of electrons is effected; nor why some atoms part with electrons more easily than others so that the flying electron loses less energy as it goes through; there is much that is obscure in the whole process. But it gives us a ready means of observation, without which indeed our knowledge of the electron would be far less than it is.

These electrons which are so made manifest by speed form but a minute fraction of their whole number. They are to be found in every body, and in every atom of every body. They form one of the elements of construction of every atom; and it is one of the most immediate aims of present research to find in what way they are built into atomic structure. In every atom there are electrons of which one can be removed at the cost of a certain amount of energy, of the order of 10^{-11} ergs; part, or perhaps all, of which may be recoverable, so that the store of energy in the atom remains what it was. The potential through which an electron must fall so that it acquires this energy, and is able to effect this removal when it strikes the atom, is known as the ionisation potential. Whether a second electron can be removed at anything like the same cost is difficult to say. There are other electrons with the atom which are intrinsically far more difficult to remove. On the other hand some atoms, for example those of the metals, have each one or more electrons which are little more than hangers-on, and are indeed removed with very little trouble. A block of pure metal is full of such loosely bound electrons, so that if an electric potential difference is maintained across the block an electron flow or electric current is produced. The metal "conducts."

At sufficiently high temperature all bodies become conductors; we must imagine that the violent thermal agitation shakes electrons free from their ties to the atoms even when at low temperature the bonds ordinarily remain unbroken. At high temperature, too, the electrons acquire high velocities as they move to and fro with their proper share of heat energy. At the surface of the hot body the electrons may break away; and hence the "thermionic emission" investigated by O. W. Richardson. So copious is this supply of electrons at the surface of a hot body that if the latter is made negative in potential relative to its surroundings there is a current discharge which may sometimes be measurable in amperes. Of course, such a current can only pass one way, negatively from the hot body, or positively towards it. So we get the basic principle of the "valve": and so Coolidge provides the electrons for projection against the target in the X-ray bulb which he has designed. At this point we find already the adaptation of our new knowledge of electrons to apparatus of extraordinarily great use to mankind.

If now we plunge a little deeper into our subject we come to certain most fascinating regions of it, where exploration is still in full progress. In one of these we find the most remarkable connection between moving electrons and electro-magnetic waves. The one, it seems, can always call up the other: and the action obeys certain precise numerical laws.

(To be continued.)

Personal.—Messrs. H. W. Smith and Co. (1920), Ltd., Electrical Wire and Cable Manufacturers, of Lydbrook, Glos, and Central House, Kingsway, London, W.C.2., have engaged Mr. W. T. Rushton, late of the Fuller Electrical and Mfg. Co., as one of their representatives for the sale of their cables and wires in London.

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TESTING MOTORS FOR ELECTRICAL INPUT.*

In determining the efficiency of a motor it is necessary to measure the input of electrical power and also the output of mechanical power. The ratio of these two quantities is equal numerically to the efficiency of the motor for the particular load at which the measurements are made. The output in mechanical power can be measured by means of a prony brake, by absorption of the power through a generator connected to the motor, or by other convenient means. Measurements of the input of a calibrated motor are made for the determination of the characteristics of stock generators and other equipments such as reducing gears, etc. When the input to a motor is to be measured for such purposes it is essential that the measurements be taken correctly in order to avoid erroneous results. The accuracy of all tests obviously depends upon the accuracy of the instruments, and care should be taken in selecting and reading the instruments if correct results are to be obtained.

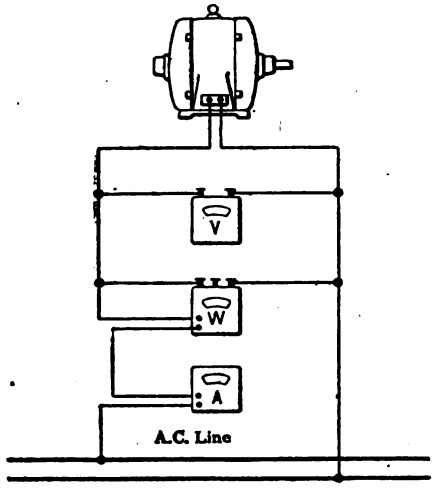


Fig. 1.—Diagram Showing Method of Testing Single-Phase Motor.

The method of measuring the input of a single-phase motor of any type is shown in Fig. 1, the ammeter, voltmeter and wattmeter being connected as indicated. The ammeter measures the current through the motor, the voltmeter measures the voltage across the terminals of the motor, and the wattmeter the total power input to the motor. With the connections as shown the wattmeter would also measure the slight losses in the voltmeter and the potential coil of the wattmeter, but for motors of 0.25 h.p. and larger this loss is so small that it may be neglected. The power-factor may be calculated by dividing the true watts as indicated by the wattmeter by the product of the volts and the amperes.

The approximate load on a three-phase motor may be determined by measuring the current in one of the three lines and the voltage across one phase using connections as shown in Fig. 2. If the voltage and current are approximately equal to the values shown on the nameplate of the motor, the motor is carrying approximately full load. If the current is much greater than that shown on the nameplate, the motor is overloaded. This method is exceedingly convenient if a wattmeter is not available, although it does not determine the efficiency of power-factor of the apparatus. It gives fairly accurate results, providing the three-phase voltages are well balanced. In cases where the voltages across the three phases vary appreciably the ammeter should be placed in each of the three lines and the average current used in determining the

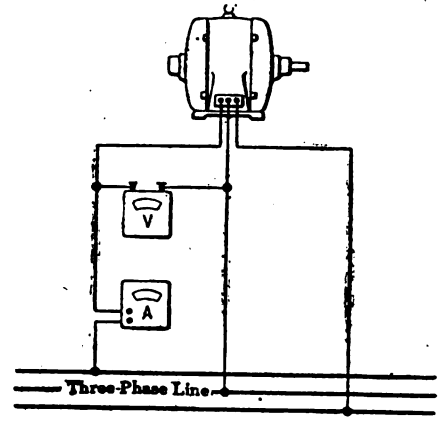


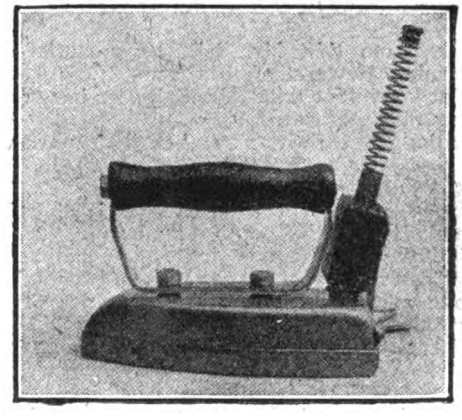
Fig. 2.—Diagram Showing Volt-Anmeter Method of Testing Three-Phase Motor.

load. In cases where a motor is very lightly loaded and the voltages of the different phases vary 2 or 3 per cent. the current in three wires may vary 20 to 30 per cent. This method of testing three-phase motors is suitable only for cases where the actual power input is not desired, but where current values and voltage are of importance. A wattmeter must be used in all cases where power input is desired unless the particular motor in question has been tested previously, using a wattmeter, and the input in watts recorded for various values of current and voltage.

* *Electrical Review*, Chicago.

"ELECT" IRONS FOR LOW VOLTAGES.

The illustration shows an "Elect" iron like the one which recently went through the test referred to in ELECTRICITY for December 24th. We have now been informed by the manufacturers—The Electric Heating Co. (G. A. Hughes), of George Street, Croydon—that they have so arranged their works and methods that 40,000 "Elect" irons are



always in stock and progress. Moreover, they have set themselves to cater for the growing business in 30 to 60 volt irons, brought about by the greater use now being made of small self-contained generating sets in country houses, farms, etc. This can be the more readily attained

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ELECTRONS.

By Sir William Bragg, K.B.E., F.R.S.

(Continued from page 94.)

Let us take as an example the production of X-rays in a Coolidge bulb. A plentiful supply of electrons is provided at the cathode by heating a fine spiral of tungsten wire to a high temperature. A high potential difference between cathodes and target is provided by some appropriate means, and the electrons are hurled at the target, each possessing an amount of energy equal to the product of the electron charge and the applied potential. Where the electrons strike, some of their energy is converted into electro-magnetic waves of very high frequency, the so-called X-rays. Suppose that we measure the energy supplied to each electron—not an easy matter with the usual arrangements, but very easily done if as in certain experiments of Duane and Hunt, at Harvard University, the potential is derived from a great storage battery of 20,000 volts. Suppose, further, that we analyse by the X-ray spectrometer the X-ray radiation that issues from the target. We find that the frequencies of the emitted rays may have a wide range of values, but that the upper limit of the frequencies is always proportional to the energy of the electron, and, therefore, to the potential imposed on the tube. This ratio remains the same no matter what is the intensity of the electron discharge, and no matter what the nature of the target. This ratio of electron energy to maximum frequency is a number which has turned up in previous cases where the emission of radiation energy has been measured: it is known as Planck's constant, and is denoted by "h." Its value is $6{\cdot}55 \times 10^{-27}$. Although the constant has been met with before, there is probably no instance where the transformation of energy which it governs is so simply displayed or so easily measured as in the case just described. In certain measurements made by Duane the potential on the tube was increased by degrees, and it was observed that rays of the given frequency appeared as soon as the energy supplied to the electron was equal to the frequency multiplied by h. As the potential was increased still further these rays increased the intensity.

It is to be observed that the production of X-rays is no aggregate of individual efforts by separate electrons: each electron produces its own train of X-rays when it strikes the target. There is no sign of any combined action, as indeed is evident from the fact that the intensity of the cathode-ray stream is without influence on the frequencies of the X-rays produced.

The crucial point is that where the energy of an electron is handed over in whole or in part, the frequency of the X-ray waves that take over the energy is determined by the quantity of energy handed over. This explains why there is a limit to the frequency of the X-rays: it is because there are some electrons, though only a fraction of the whole number, which give up all their energy to the formation of X-rays at the moment of striking, before they have lost energy in collisions. The rest of the rays, all those which have lesser frequencies, will come from electrons that have lost speed in this way, or possibly have transferred only part of their energy. The atom of the target is playing the part of a transformer, and does not determine the frequency, so far as these effects are concerned.

All this is wonderful enough; but the marvel is greatly increased by the discovery that the effect is reciprocal. Just as the swiftly moving electrons excite X-rays, so X-rays when they strike any substance lose their energy, which now appears as the energy of moving electrons. And, again, we find the same variation in the result and the same limit to that variation. Among the electrons set in motion we find, examining them as soon as possible after their motion has begun, every variety of energy-content up to a certain critical value which is equal to the frequency of the X-rays multiplied by the same constant h. It is to be observed that we cannot measure all the electron velocities as soon as they exist, because some of the motions begin in the body of the substance, into which the X-rays have penetrated, and have lost speed on the way out. Again, therefore, there is nothing against the hypothesis that the energy of every electron set going by waves of given frequency is originally the same, and is determined by the standard condition already given.

Not only in the case of X-rays are these effects observed, but also in the case of light. The only difference is that the frequencies of light vibrations are some 10,000 times less than those of X-rays, and the electron energies are correspondingly smaller. When the light waves produce the electrons we have what is known as the photo-electric effect. The production of light by electrons has been much studied recently in experiments to find "resonance-potentials," that is to say, the magnitudes of potentials which must act on electrons so as to give them enough energy to excite certain particular radiation from atoms on which they fall.

(To be continued.)

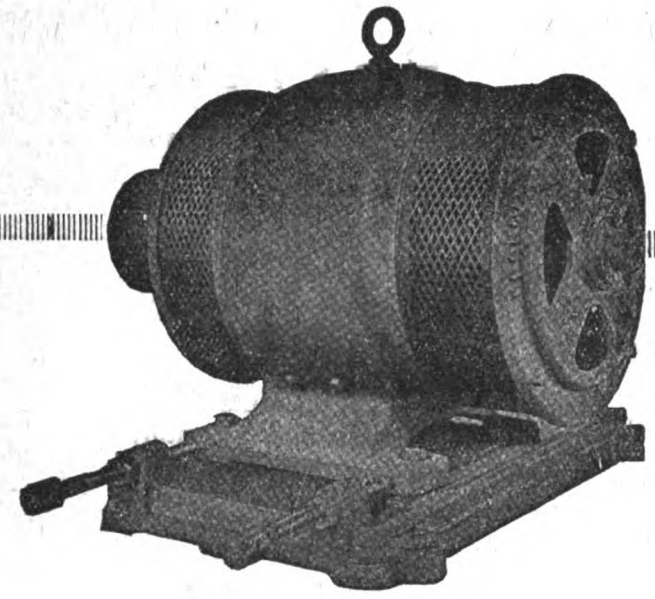
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

In any comments upon the Gas *v.* Electricity controversy which has raged for so many years past, I have always held that there is plenty of room for both commodities, each being peculiarly suited to certain sets of conditions and circumstances. In the lighting field there will always be a natural friendly rivalry between the two illuminants, which only makes for greater efficiency and is therefore to be commended and encouraged. In the matter of heating and cooking the issues are not quite so clear, and the respective sponsors of both systems are hard put to find convincing arguments against their opponents. In the power field, however, electricity reigns supreme, and it is interesting to record that the use of electrical energy for power purposes in gasworks has increased considerably of late years.

Rivals no Longer.

This application of electric power to gasworks was the subject of a recent Institution paper, whilst I believe certain gentlemen interested in gas were somewhat surprised on the occasion of an officially conducted visit to certain large gasworks to find electric power so largely in evidence. Originally applied mainly in connection with the driving of automatic stokers, coal conveyers, etc., electric motors have more recently been extended to pumps, washers, and other gas-making appliances, and it is stated that there is one gas company which makes use of no less than one million units per annum, all generated on the premises. An interesting special application of electricity in connection with gas supply is in a new electrical measuring device for metering the flow of gas; it is claimed that this will enable the gas engineer to obtain detailed records of output on exactly similar lines to those obtained in an electricity supply station.

According to the *Gas Journal* a scheme, still in the experimental stage, contemplates a still more radical departure, viz., the use of the electric arc for coal carbonisation. It is recorded that Mr. J. Mogford, gas and electrical engineer of Briton Ferry, suggested such a scheme some years ago, and Mr. C. H. Merz, to whom the idea was submitted has also interested himself in a system of carbonisation, which it is proposed to combine with the generation of electrical energy. Thus the sharp distinction formerly existing between the electrical and the gas industry is disappearing. The two are inter-dependent and by wholesome co-operation can do much to advance both their own interests and those of the consuming public.

Having thus cleared the air and disposed of any suspicion of partisanship, perhaps I may be allowed to proffer a tip to that section of the trade which caters for gas fittings. There is an apparent tendency to unduly cheapen the class of fitting now being offered to the public, and some cheap and *nasty* specimens are on sale which are calculated to do more harm than good to the interests of gas lighting. I had occasion to purchase an inverted fitting the other day and was treated to one of the samples of which I now write. Had I not studied the pros and cons of incandescent gas lighting and been familiar with the fundamental principles of a correct "mixture" I might still be waiting for a good light.

The most important item in any incandescent gas burner is the nipple, or that component which admits the flow of gas in the correct proportion for admixture with the air entering on the atmospheric side of the burner. There are well-known tests which gas fitters apply to determine whether a burner is correctly adjusted, but the average consumer, buying one of these fittings and screwing it in to his existing outlets, be they of the bracket or pendant order, does not understand the first thing about it. When my burner first came home from the shop the nipple was missing altogether, and I had to pay a second visit to the dealer to obtain one. Rank carelessness in salesmanship to start with. On removing the old upright burner and substituting the inverted, a very poor illumination resulted, no matter what the adjustment of the extra air inlet.

I took the whole affair to bits and found that the nipple, a cheap brass stamping, with pressed-in diaphragm, was pierced with three very indefinite openings, which might, or might not, pass sufficient gas. I reamed them out slightly, and by careful trial and error succeeded in obtaining a correct mixture with a shaped flame which fully incandesced the mantle, and that fitting is now as good as the best obtainable of similar capacity. I grant that it is not easy to secure absolute uniformity in the piercing of these miniature diaphragms, especially on the cheaper fittings, but I do think the trade should do all possible to ensure that the nipples at all events pass enough gas at the outset to give maximum illuminating efficiency. Keeping them up to the scratch by subsequent periodical cleaning is then a matter for the consumer or whomever he deputes to do this for him.

A propos the periodical attention required by light units in the matter of cleansing, renewal of gas mantles or blackened electric globes, cleaning of globes and reflectors, etc., any scheme for taking care of this is well worth consideration, especially in factories and large buildings where a considerable number of lighting units are installed. The overall illuminating efficiency is thereby maintained at a much higher average figure than where the fittings are left to themselves or only cleaned and looked after in a haphazard way. In this connection it is interesting to note that the Commonwealth Edison Company of Chicago maintains lighting units for nearly 37,000 customers at a fixed rate per lamp per month (varying from 37 cents to 1½ dollars per unit). For this inclusive charge the company cleans the

Maintenance of Light Units.

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lamps, globes and reflectors at least once a month, and, where special factory conditions require more frequent cleaning, it makes a practice of cleaning twice monthly without extra charge.

The Time Value of a Telegraph Circuit.

We can readily appreciate the money value per message which has to traverse a submarine cable which has cost thousands of pounds to manufacture, lay, and subsequently maintain, but it is not quite so easy to appreciate the loss in revenue arising out of a simple breakdown of one of the familiar land lines which run alongside our roads and railways. A recent police court case threw interesting light on this subject, when it was stated that a boy who threw a stone and broke a 9¾d. insulator on a telegraph pole at Birkenhead, thereby actually did some £12 worth of damage, inasmuch as the circuit affected, which took in Ireland, Llandudno and London, was out of order for 10 hours, with a consequent loss of 2s. for every five minutes. Small boys addicted to stone throwing should read, mark, learn and inwardly digest this incident.

The Electric Vehicle.

Despite its proved utility and convenience, the electric vehicle makes but slow progress in this country as compared with the States, and in this connection my contemporary, *Municipal Engineering*, makes an excellent suggestion, viz., an Electric Vehicle Exhibition. New York is organising such an exhibition, and the time would appear ripe for British manufacturers and others interested in this branch of the industry to follow suit. Although the number of makers of heavy vehicles of this type is limited, there are quite a host of electric trucks and accessories of all kinds, which would enable a representative collection of exhibits to be collected and grouped to advantage. The electric vehicle is not so widely known as it might be, having regard to its wide application. In this connection the example of Glasgow is to be applauded; Glasgow Corporation, one the first to support and encourage battery traction, is building and equipping a garage with all necessary appliances for housing, maintaining and charging a large number of electrics. A noteworthy feature is that university students will be afforded facilities at this garage for studying the subject of electric battery traction at first hand.

ELEKTRON.

ELECTRICAL BUSINESS IN NORWAY.

In the General Report on the Industrial and Economic Situation in Norway in December last, issued by the Dept. of Overseas Trade, Mr. C. L. Pans, C.B.E., Commercial Sec. to H.M. Legation, Christiania, it is stated that during the year German firms re-established their position in the market, and an expert estimated that they had secured 25 per cent. of the business in all kinds of electrical machinery. Imports from the United Kingdom were small except that British exporters secured a fair share of the business in cables which was considerable.

At the present moment the demand in Norway has relaxed owing to the stringency of the money market. It is, however, the opinion of an expert that rapid development will not long be retarded as it is estimated that about 1,300,000 h.p. of generating plant has been installed in this country, and available figures appear to indicate that a large proportion of this power still remains to be disposed of among consumers. There will, therefore, necessarily continue to be a large demand for cables and smaller kinds of machinery such as transformers, motors and cooking and heating apparatus. The use of electricity for cooking and heating has increased very greatly owing to the high cost of coal, and it is thought that there is a great future for cooking and heating apparatus in this country.

It is, however, obvious, that the exploitation of power, whether harnessed or unharnessed, must depend very considerably upon the position of the money market and the possibility of raising the requisite capital.

At the present moment German firms are booking a considerable amount of business. They have proved themselves able to make delivery and are underselling all competitors, owing chiefly to the low rate of the mark and the high rates of the pound and dollar. Norwegian factories are also, for the same reason, able to undersell British and American firms.

THE BRITISH INDUSTRIES FAIR, BIRMINGHAM.

BY A SPECIAL CORRESPONDENT.

A visitor to the British Industries Fair at the Castle Bromwich Aerodrome, Birmingham, comes away with very different feelings from those which he has after leaving the Fair at the White City in London, if his interests are electrical. The display of electrical apparatus and fittings at Birmingham leaves cause for little complaint, although in fairness to London it should be pointed out that the electrical exhibits were not intended to be a strong feature. Indeed they are nearly non-existent. In Birmingham, on the other hand, there is a special lighting, heating, and cooking section, which is not only attractive in itself for the high standard of excellence achieved, both in design and finish, but for the new things to be seen, of which there are quite a number. It is impossible, after a tour of these stands, not to appreciate that there is little in the way of electric light, cooking and heating apparatus which the British manufacturer cannot now turn out. A candid chronicler must report that business has been dull, both at the London and the Birmingham Fairs, and for that we have to thank the trade depression. Nothing but the question of price can help an upward movement, and we know the extent to which labour problems here are handicapping the British manufacturer. It is little use harping on the fact that we are now making this or that article which before the war was the monopoly of some other country. The point is, can we sell it at a competitive price? Notwithstanding the difficulties under which our manufacturers are struggling, there are many lines to be seen at Birmingham in which the prices are not only competitive, but may be described as "cut," but until the general level of output per man is increased, we are likely to feel the increasing pressure of foreign competition. Whatever views one may hold as to our trade policy, from the point of view of the Government no amount of legislation can be expected to counterbalance artificial conditions created by the short-sightedness of Labour, and every effort must be made to improve the position in that respect. Employers have had and are having such a bad time that there is a disposition, natural enough, perhaps, on the part of some, to take the view that it must be left to unemployment and the consequent distress to bring home to Labour what is needed of it in helping to bring about more stable conditions. That, however, is an attitude of mind which must be set aside. The problems facing employers, irritating though they are, when some of the causes are realised, can only satisfactorily be dealt with in a human spirit, and happily that is the case with the large majority of employers. It is impossible, however, not to couple the admittedly less satisfactory results from the British Trade Fairs this year compared with last with the uncommercial demands of Labour both as to rates of pay and quantity of output. The cardinal fact is that whatever the ability of the world to buy, it will not pay

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high prices for British goods when it can get what it wants in other countries at lower prices. At the present moment, however, the world is not in the financial position to pay high prices, a very good reason in itself why trade is bad under conditions of high labour costs and low output per man.

NOTES ON THE EXHIBITS.

The General Electric Co., Ltd., displays a variety of modern electrical apparatus, much of which, of course, is well known. There is a new type of Witton Kramer bench drill, and specially interesting at a time when electric lighting for motor-cars and cycles is rapidly displacing acetylene, and the "Klersite" dynamo for petrol-driven commercial vehicle lighting (described in ELECTRICITY, February 25, page 120). There is a pleasing selection of electric radiators, together with monorail hoists, lifting magnets, a 300 ampere Salford Switch and fuse, a pedestal mounted motor-control panel, auto-transformers, starters, etc. The Stand itself is illuminated by the Company's "City" lanterns and high candle-power Osram lamps, the current being obtained from a motor generator set of the Company's own make, which also supplies the lighting of a considerable portion of the exhibition.

J. H. Tucker and Co., Ltd., of Birmingham have a very complete exhibit of their electric light and power accessories. One piece of apparatus not yet in production, but soon to be, is an interlocking 10 amp. switch and plug for radiator work. This is so arranged that when the plug is out the switch cannot be operated, and the action of pulling out the plug operates the switch and leaves the contacts dead. There is a three pin plug with an earthing device. Another interesting device is the "Tucker" patent quick make-and-break ironclad switch. The design of this switch case permits of it being used with either a large central tapped hole at each end for the incoming and outgoing cables, or two smaller holes. This is effected by means of interchangeable and removable adaptors, which can also be provided with recessed bodies and wood-bushed holes for sealing hygroscopic cables, and with watertight glands. The switchboard and switchgear exhibits consist of a complete accumulator switchboard for use in conjunction with batteries and lighting sets for country house and similar lighting plants. "Tucker's" are pioneers of tumbler switches, and the exhibit certainly does justice to the firm's reputation in this respect. There is an addition to the range of flat switches in which both a quick "make" and "break" action is obtained without in anyway altering the size and appearance of the switch. The design and finish of the switch plates is a pride of the finishing shop, and the action of some of the switches can only be described as beautiful.

Another general exhibit is that of Siemens Bros. and Co., Ltd. (Woolwich, London), the most conspicuous item of which is the automatic telephone system, which is actually wired for 30 lines for stands in the Exhibition. This is an automatic system intended for use in large business houses, factories and institutions, and is necessarily too complicated to be described in detail in a short notice such as this. Both wall and table instruments are supplied, and the required number is obtained by the calling subscriber operating a dial plate on the instrument. A very large number of business houses are now equipped with this system. There is a special show of ebonite, manufactured at Woolwich, in sheet, rod and tube for various electrical purposes. Mine shaft signalling apparatus, to comply with the Coal Mines Act, is also shown and the robustness of this together with the accuracy of working goes a long way to demonstrate the advantages of electrical over mechanical signalling for this purpose. There are in addition, of course, Britannia lamps, Stannos wiring, electric lighting fittings, etc. A bicycle electric lighting set, using dry batteries, is further evidence of the manner in which electric lighting is ousting acetylene for bicycle and motor-cycle lighting, and the proverbial reliability of Siemens dry cells is not the least important factor in the efficiency of this particular set.

(To be continued).

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 113.

I have received advice to fit magnetic clutches in my machine shop instead of the fast and loose pulleys so necessary for machine operation. Can any reader tell me how these are operated, and what type of clutches I shall require? My lighting voltage is 230 volts.—"PLANER."

QUESTION No. 114.

What are the advantages of shunt motors over series motors for lift operation, or *vice versa?* I am fitting shunt motors to some lifts in the works where I am employed, these being already on hand. Can any reader give me some practical hints concerning operation, controllers, limit gear, etc.?—"FLOOR."

(Replies to Questions Nos. 113 and 114 must be received not later than March 26, 1921.)

Answers to Questions.

QUESTION No. 109.

I have a motor starter with the resistance burnt out. It is 40 horse-power, 440 volts. How can I calculate the size and quantity of wire required to rewind this resistance to start against full load?—"ASTATIC."

REPLIES TO QUESTION No. 109.

The first prize (10s.) has been awarded to Mr. G. White, 116, Queen's Park Road, Brighton, for the following reply:—

In calculating the dimensions of a motor starter to start against load, the resistance of the armature circuit, including series winding, if any, must be ascertained. We will call this R_a. The full load starting current must also be known. This seldom exceeds 20 per cent. over normal full load current.

Assuming motor has an efficiency of 85 per cent. the full load current will be:—

$$I = \frac{40 \times 746}{440 \times \cdot 85} = 80 \text{ amps.}$$

$$\therefore \quad I_m = 100 \text{ amps.}$$

In order that machine will not be subjected to an excessive jerk at starting, it is usual to allow the motor to start on the second contact when dealing with machines of this size. The values of R_1 and R_2 can therefore be found:—

$$R_1 = \frac{V}{\frac{1}{2}I_m} \text{ and } R_2 = \frac{V}{I_m}$$

The values of R_1 and R_2 include resistance R_a as shown by Fig. 1 (overleaf).

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With a properly-designed starter the current variation in a motor starting against full load will be somewhat as indicated by Fig. 2, from which it will be seen that

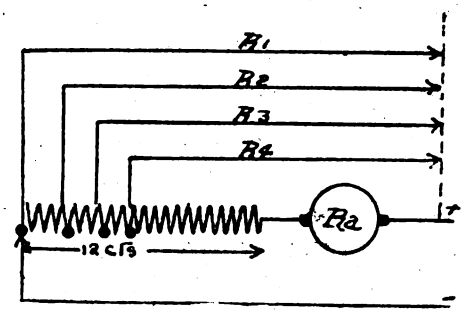


FIG. 1.

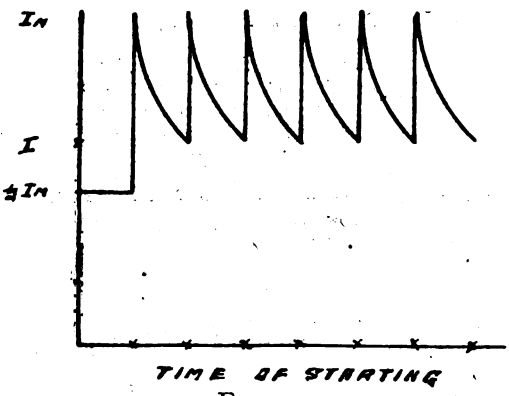


FIG. 2.

the value of current just before leaving contact 2 = I

$\therefore V = e_1 + IR_2$ where e_1 represents back e.m.f. induced in armature.

At instant of contact on (3) $V = e_1 + I_m R_2$.

$\therefore$ from above equations :— $V - e_1 = IR_2$.

$V - e_1 = I_m R_3$

$\therefore IR_2 = I_m R_3 \quad \therefore \frac{R_2}{R_3} = \frac{I_m}{I}$

Similarly it can be shown $\frac{R_2}{R_3} = \frac{R_3}{R_4} = \frac{R_{n-1}}{R_n} = K$;

Suppose, for example, starter has 12 contacts and armature resistance = ·25.

$$\frac{R_{11}}{R_{12}} = \frac{R_{11}}{R_a} = K \quad \therefore R_{11} = KR_a$$
$$R_{10} = KR_{11} = K^2R_a$$
$$R_2 = KR_3 = K^{10}R_a$$
$$= \frac{V}{I_m}$$
$$\therefore \frac{440}{100} = K^{10} \times \cdot 25$$
$$\therefore K = 1\cdot 332.$$

Since $\frac{R_2}{R_3} = K$, $R_3 = \frac{R_2}{K}$. All the values of resistance can be found in this way; in our example they are :—

R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}	R_a
8·8	4·4	3·3	2·48	1·86	1·4	1·05	·79	·59	·44	·33	·25

The resistance of each section of starter is found by substracting, thus :—Sect. I. = $R_1 - R_2$.

Sect. :—

1	2	3	4	5	6	7	8	9	10	11	Armature.
4·4	1·1	·82	·62	·46	·35	·26	·2	·15	1·1	·08	,,

The size of wire required can be determined as follows :—

R = resistance of wire.
I = average value of current = 90.
a = cross section in sq. cm.
l = length of wire cms.
P = Spec. Res. in ohms per cm. cube of material.
s = Spec. heat of material used.
g = Spec. weight of material.
$T°$ = temp. rise per second above atmosphere.

Rate of generation of heat $= 0\cdot 24\ I^2R.$
$= 0\cdot 24\ \frac{I^2Pl}{a}$

To produce above heat in one second, heat generated $= l \times a \times g \times s \times T°$.

Radiation may be neglected because starting time is so short.

Then $l \times a \times g \times s \times T° = 0\cdot 24\ \frac{I^2\,Pl}{a}$

$$T° = 0\cdot 24\ \frac{I^2}{a^2} \times \frac{P}{sg}$$

Suppose wire carries current for t secs. and $T_1°$ = permissible temp. rise, then $T° = \frac{T_1°}{t}$

$\frac{T^{10}}{t} = \cdot 024 \frac{I^2}{a^2} \times \frac{P}{sg}$ from which $a = \cdot 49 I \sqrt{\frac{P}{sg} \times \frac{t}{T_1°}}$

$T_1°$ is usually 150° for starters.

$$\therefore \quad a = \cdot 04\ I \sqrt{\frac{P}{sg} \times t}$$

Applying this formula to each section of resistance would give a different value for a for each one since t varies for each section. It is usual to work out value of a for last section and choose a suitable size for the whole starter, using two or more wires in parallel for the last sections as found necessary. The length of wire in each section will be given by

$$l = \frac{R \times a}{P}$$

W. G. WHITE.

N.B.—*The* Two *second prize-winners' answers will appear shortly.*

NOTES ON THE DESIGN OF A LARGE POWER STATION.

The Informal Meetings of the Institution of Electrical Engineers, held at Staple Inn Buildings on alternate Monday evenings, are attracting large numbers, and the discussion on "Some Notes on the Design of a large Power Station," opened by Mr. J. R. Cowie (Member of Council), on the 14th ult., filled the hall. Mr. A. F. Harmer in the chair referred to the presence of several members of the E.P.E.A.

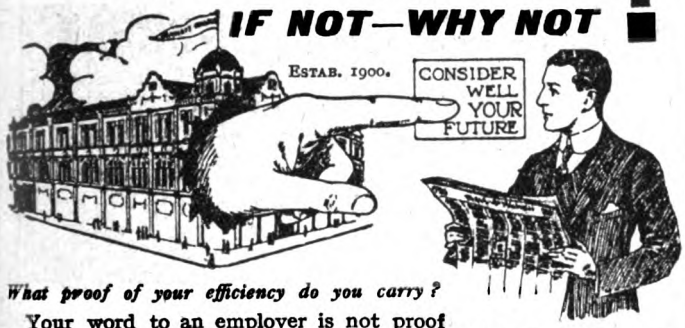
Mr. Cowie had Dalmarnock (Glasgow) Station in continual reference for his subject and he was provided with copious plans and photos kindly lent by Mr. R. B. Mitchell, Chief Engineer of this station. He proceeded to describe in detail the super-station. First determining the site by study a map of the district, then the position or roads and accessibility to rail and water. Next the erection from the concrete raft of the footings to the superstructure. He allotted the site its due proportions for stores, boilers, machines, etc., and described in detail and with reasons, the lay-out system and voltages he would adopt.

He asked members to give experiences of economisers

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with steel tubes, and he also thought further information was required regarding the enormous accretions of ash with post-war fuel.

In the subsequent questions and discussions Dr. R. D. Gifford offered the idea of cooling by liquid air, and on the question of the drive of the station auxiliaries (pumps, fans, condensing plant) advocated a D.C. house set. This drew from Mr. Cowies the naïve admission that while D.C. is better, they were preaching A.C. drive to consumers in Glasgow and thought it policy to stick to A.C. in their station.

Mr. S Utting referred to the extension of furnace air heating methods, and Dr. Kapp thought it was making a virtue of necessity as the hot air has to be evacuated. Mr. W. N. C. Clinch spoke of steel economisers, and Mr. E. F. Hetherington knew of a case of prevision that galvanised the tubes yet did not prevent pitting. Mr. A. F. Harmer elicited Mr. Cowie's preference for keeping all metering on the low tension side.

Mr. W. J. Oswald, Mr. H. B. Jenkins, Mr. L. M. Jockel, Mr. W. Dargavel, Mr. A. E. Gott, Major K. Edgcumbe, Major R. Grierson and Mr. A. B. Eason also spoke. The inevitable reminder that the generators should be at the pit-head, brought the reply that Dalmarnock in full blast will make small gulps of the output of any one colliery in Scotland; and when it was pointed out that Dalmarnock weighed coal twice on acceptance—before and after tipping—Mr. Cowie was ready with knowledge (by hearsay) of a wagon repair works that kept all its fires going on the coal scraped from wagons sent for repair.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

THE MECHANICAL WORLD ELECTRICAL POCKET BOOK, 1921. (Emmott. 2s. net.)—The new edition of this useful book has, as usual, been most carefully revised by the Editor and certain improvements have been made, including the re-writing of the section on Motor Starters and Controllers. The section on Transmission Conductors and Cables has been revised, and a new table of maximum currents has been introduced. Altogether every care has been taken to keep it as accurate as possible.

ELEMENTS OF THE MATHEMATICAL THEORY OF ELECTRICITY AND MAGNETISM. By Sir J. J. Thomson, O.M. Fifth edition. (Cambridge University Press. 25s. net.)—Very little comment is needed with regard to this new edition of Professor Thomson's splendid work. The fact that it has met with such a steady sale since its first appearance in 1895 is a sure testimonial of the high opinion in which it is held in the electrical world in this country and the Colonies, as well as in America. A few additions have been made to the text and some misprints corrected, and the author acknowledges with pleasure the assistance which has been given to him by his son, Mr. C. P. Thomson, who is a Fellow and Lecturer of Corpus Christi College, Cambridge. To all who have to study the Mathematical Theory of Electricity and Magnetism this book can be safely recommended as the finest possible introduction to the fundamental principles of the theory as well as of other more important applications, bearing in mind that, with the exception of a few paragraphs, no more advanced mathematical knowledge is required from the reader than an acquaintance with the Elementary Principles of the Differential Calculus.

THE JOURNAL OF INSTITUTE OF METALS, Vol. XXIV. Over 547 pages and 40 plates. (Institute of Metals, 36, Victoria Street, London, S.W.1. 31s. 6d. net.)—The latest issue of the *Journal of the Institute of Metals* well maintains the high standard of this important metallurgical publication, for the editing of which Mr. G. Shaw Scott, M.Sc., is again responsible. Special interest attaches to the hitherto unpublished lecture of Professor C. A. F. Benedicks, of Stockholm University, in which he announces his discovery of thermo-electric effects on homogeneous metals. Previously it had been held that dissimilar material constituted the basis of thermo-electric effects, but this view is now conclusively disproved. The wide application of thermo-electric pyrometers for engineering work arouses interest in the possible practical uses of the discovery. The major portion of the *Journal* consists of a series of ten papers presented at the Barrow-in-Furness meeting. Of these the biggest, and perhaps the most novel paper, is that contributed by Miss Constance F. Elam, jointly with Professor Carpenter, the authors advancing what is probably the last word on the much debated subject of crystal growth and recrystallisation in metals. Several other papers deal with practical problems in the brass foundry. More complete than ever before is the final or "Abstracts" section of the *Journal*. Here we have over 100 pages of concise summaries of the world's metallurgical literature of the past six months. These abstracts should be invaluable to the busy man. They bring to a focus everything that he should know regarding the utilisation of, and research in, the non-ferrous metals. The large number of plates are beautifully reproduced from photographs. Issued as heretofore in cloth-bound covers, the *Journal*, in spite of its large size, is unaltered in price.

THE ELECTRICAL CONTRACTORS' YEAR BOOK, 1920-21. (Electrical Contractors' Association. 2s. 6d. net.)—The new edition of this year book of the Electrical Contractors' Association, together with its kindred organisations, the N.E.C.T.A., Limited, and the National Federated Electrical Association, gives a very complete list of all the members of the Association in England, Wales and Ireland, as well as a brief but interesting history of the E.C.A. and its activities. It contains the official report of the Chairman for the last twelve months, as well as sections dealing with the laws regarding the supply of electricity, the functions of the National Joint Industrial Council for the Electrical Contracting Industry and of the District Councils scattered up and down the country, and a copy of the Memorandum of Agreement between the National Federated Electrical Association and the Electrical Trades Union on August 27, 1920. It also gives the working rules agreed upon for various districts, and may be looked upon as an absolute necessity to every electrical contractor in the United Kingdom. We have no doubt that it will sell very rapidly.

Personal.—Messrs. H. W. Smith & Co. (1920), Ltd., Electrical Wire and Cable Manufacturers, of Lydbrook, Glos., and Central House, Kingsway, London, W.C.2, have engaged Mr. D. C. Jewell as representative for the North-Eastern Counties. Mr. Jewell was for a long time with Messrs. Sir W. Armstrong Whitworth & Co., Ltd., at their Elswick works.

The Wild-Barfield German Patents.—Messrs. C. Lorenz Aktienesellschaft, Berlin, have purchased the Wild-Barfield Patent Rights for Germany, Poland and the former Austria-Hungary. Messrs. Lorenz have already placed a first order with Automatic & Electric Furnaces, Ltd., for various parts to complete nearly 100 furnaces.

Sales Management.—Vol. I., No. 1, of a new monthly journal, entitled *Sales Management*, made its appearance last month, under the auspices of the Louis Cassier Co., Ltd. The policy pursued is to cover the whole field of creating and supplying demand, as well as the application of scientific principles of practical salesmanship. It will deal with current sales campaigns, indicate opportunities, analyse the organisation plans of large sales departments, and offer helpful suggestions for improving publicity matter of all kinds. Advertising, transport, overseas markets, and the selection and management of salesmen are to receive their full share of attention. As the only British journal of its kind, it should appeal to sales managers, advertising managers, and all business men who wish to develop selling ability and so eliminate wasteful effort in connection with selling and distribution. The price is 1s. 6d. per issue.

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Various Items.

Dublin.—The employees of the United Tramways Company have decided not to press their claim for an increase of wages until a decision is arrived at in the case of the English tramwaymen.

Charing Cross and Met. E.S. Companies.—Both have had a satisfactory year's working. The former is paying a final dividend, making with the interim dividend 8 per cent. for the year, and the latter 7 per cent.

New Zealand.—The Government has sanctioned the raising of £1,708,910 by the Wellington City Council for various municipal improvements, and £95,000 by the Wanganui Borough Council for tramway extensions. Invercargill Borough Council is contemplating extensions to its railways, electric light and power schemes, etc.

Domestic Heating, Lighting and Labour Saving.—An exhibition, to be called "Indoors and Out," is being organised by "The Woman's Leader" and "The Women's Institutes." It will be held at the Central Hall, Westminster, from May 23 to 28. The organiser is Miss E. M. James, Exhibition Department, "The Woman's Leader," 62, Oxford Street, W. 1.

Serb, Croat, Slovene State.—Tenders are required for a power station, sub-station, transmission lines, etc., for the provision of an electrical supply in Belgrade, Semlin, etc., from a power station at Kostolac. Tenders must be submitted before May 1 to the Director, Ministry of Public Works, Belgrade. A translation of the specification, etc., may be seen in Room 48, Department of Overseas Trade, 35, Old Queen Street, S.W.1

Slides on "Wireless."—Messrs. Newton & Co., Ltd., have recently prepared a set of lantern slides for a lecture on "Wireless Telegraphy," dealing more particularly with the Elwell-Poulsen system. They are accompanied by a full set of notes which provide alternative methods of treatment for audiences of varying degrees of acquaintance with the subject. Many of the slides are from hitherto unpublished photographs, and we think should prove both interesting and useful to many of our readers. Messrs. Newton's address is 37, King Street, Covent Garden, W.C.2, and a small charge is made for the hire of the set.

A New Series of Cheap Technical Books.—Sir Isaac Pitman & Sons, Ltd., have now commenced issuing their new Technical Primer Series, which promises to be a very large one. The first 8 volumes are ready and several others will be published during this month. These little books are in foolscap 8vo, contain about 120 pages with an attractive cover design, are printed on good paper, and well illustrated. The price is 2s. 6d. net, each volume. The series will eventually contain volumes on every phase and branch of technology. A list giving full details may be obtained on application to them or to ELECTRICITY Office. Write for it.

Meetings.—A meeting of the Wireless Section of the Inst.E.E., will be held on Wednesday, 16th inst., at 6 p.m., at the Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W., when the following papers will be read and discussed:—"On the effect of Electron emission on the Temperature of the Filament and anode of a Thermionic Valve," by G. Stead, M.A. "On some Thermionic Tube Circuits for Relaying and Measuring," by Miss W. A. Leyshon and Dr. W. H. Eccles. Remember, on this occasion the meeting is at the Institution of Mechanical Engineers and not at the Institution of Civil Engineers.—The next Ordinary Meeting of the Society of Engineers will be held in the Apartments of the Geological Society, Burlington House, W., on Monday, 7th inst., at 5.30 p.m. Paper: "Some Modern Engineering Practice in America," by Robert W. A. Brewer, A.M.I.C.E.—The Junior Inst. Eng. will meet on Friday, 4th inst., at Caxton Hall, at 8 p.m. Lecturette, "Manufacture of Gun-cotton," by W. H. Simmons. Also on Friday, 11th inst., at 39, Victoria Street, at 8 p.m. Lecturette, "Electrical Drive in the Cotton Trade," by A. T. McGuire (slides); and on Friday, 18th inst., at Caxton Hall, at 8 p.m. Lecturette, "Hand-Operated Appliances for Lifting and Transporting," by T. E. Dimbloby (slides).

I.E.E. Summer Meeting.—This will take place in Scotland from June 7 to 10. The first two days will be spent in Glasgow, when visits will be paid to the new Power Station at Dalmarnock, and to works and other places of interest. There will also be papers on that Power Station and on the Hydro-Electric Power Resources of Scotland. Arrangements have been made for a Clyde trip on the 8th. On the 9th, the party will proceed by special train to Fort William or Banavie (Inverness Canal), and on the following day by steamer down Loch Linnhe to Kinlochleven, where the Hydro-Electric Installation of the British Aluminium Co. will be visited. In the afternoon the steamer will proceed to Oban. Full details will shortly be issued.

Patents.—An Inter-Departmental Committee has been established by the Department of Scientific and Industrial Research with the following terms of reference:—(1) To consider the methods of dealing with inventions made by workers aided or maintained from public funds, whether such workers be engaged (a) as research workers, or (b) in some other technical capacity, so as to give a fair reward to the inventor and thus encourage further effort, to secure the utilisation to industry of suitable inventions and to protect the national interest; and (2) To outline a course of procedure in respect of inventions arising out of State aided or supported work, which shall further these aims and be suitable for adoption by all Government Departments concerned. The Sec. is Mr. A. Abbott (16 & 18, Old Queen Street, Westminster, S.W.1).

Trade Notes.

A new folder from the **Edison Swan Electric Co., Ltd.** (Ponders End, Middlesex), refers to Ediswan circuit breakers, and states that the company specialises in "special" switching jobs. Full particulars of the breakers are given in List No. AA172.

The Capac Co., Ltd. (2, Woodstock Street, Oxford Street, W.1), have developed a device called the "Sonoscope" with Binaural Attachments for the location of mechanical defects in moving machinery. It serves the engineer in the same way as the stethoscope serves the medical profession.

Harwol Specialties Co. (51, Oldhall Street, Liverpool) send a leaflet illustrating an "automatic electric lamp." It is made in two types: (1) pocket type, (2) box type. In the former the working of a lever, and in the latter the pulling out of a spring, operates a self-contained generator so as to light the lamp. The box type is carried by a strap suspended round the neck. It weighs 24 oz. The weight of the pocket type is 12 oz.

Messrs. H. W. Smith & Co. (1920), Ltd.—Electrical Wire and Cable Manufacturers, of Lydbrook, Glos. and Central House, Kingsway, London, W.C.2, have issued, pending their complete Catalogue being delivered from the printers, a four-page list, giving particulars of sizes and prices of V.I.R. Cables, Flexibles, Bell Wires and Cotton-covered Wires, and will be glad to supply a copy to anyone interested on receipt of trade application.

Sunco British porcelain-clad connectors are listed in a leaflet issued by the **Sun Electrical Co.** The actual connectors are of brass and fit snugly into English vitreous bodies—made by a new process, which ensures uniformity. The screws have cut threads (not rolled), and are thoroughly protected by porcelain under all conditions. The diameter of the screw-hole is such that no specially small screw-driver is required, and the wires are firmly gripped without fear of shorts or earths.

Blackman Expert Co., Ltd. (374, Euston Road, N.W.1), are just placing on the market a new design of "Streamline" Fan. Each of its six blades is hollow, both sides being convexed with central internal stays for holding them to the boss of the wheel. There are no projections, the whole blade presenting a smooth surface offering the minimum resistance to the air flow; the mechanical efficiency, it is claimed, being about 30 p. c. higher than that hitherto attained. The runner is symmetrical so that it can be run in either direction, and is strongly built for high-speed work. The blades being separately renewable, without dismantling or even dismounting the whole fan, valuable facilities are presented as regards packing and shipping measurements,

CONNOLLY'S (BLACKLEY) Ltd.,
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Insulated Wires and Cables of all Descriptions,

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

MARCH 11, 1921.

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THE USE OF LIGHT AS AN AID TO PUBLICITY.

At the meeting of the Illuminating Engineering Society on February 24, two introductory papers to the discussion on the above subject were read, Captain E. Stroud dealing with Show-Window Lighting and Mr. E. C. Leachman with Illuminated Signs.

Captain Stroud's paper was devoted largely to a discussion of the best method of concealing lighting for windows, and it was taken for granted that the exposure of bare unscreened lamps amongst the goods was a mistake. The object of the light is to show up the contents of the window, and if bare lamps are used in this way the waste of light is at least 60 per cent. Assuming that concealed lighting is adopted the choice of suitable reflectors is very important. Good distribution of light cannot be effected by lamps projecting out of unsuitable reflectors, as occurs frequently when a gas-filled lamp is inserted in a fitting intended for ordinary vacuum type lamps. Lamps are best spaced along the top front edge of the window. They may be completely concealed, but there is no objection to using a diffusing silk curtain or translucent luminous sign bearing the name of the shop as a covering, provided the filaments of lamps are effectually screened. The background against which goods are seen is of importance. A glass background is unfortunate because it causes people outside the shop to see inconvenient direct reflections of the light-sources. On the other hand a glass back might be considered desirable during the day in order to admit daylight. The correct course is to make use of a blind which could be let down to the correct level when artificial light is used.

A well-lighted window, it was remarked, formed one of the cheapest advertisements, and would attract people from right across the street. Window-dressing and lighting should be considered together. A shop window should contain a few specimens attractively arranged, it should not be a catalogue. A window completely crowded up with small objects could not be properly lighted. The amount of light needed varied according to the class of goods but might range from ten 30 foot-candles, involving a consumption of energy of from 0.5 to 1.25 watts per cubic foot.

Masses of bright lights adjacent to windows were most undesirable as they "killed" the effect. If owners of shops thought such lights necessary to attract customers from a distance the lamps should be screened in suitable lanterns or used behind transparencies, etc., and should not be in the immediate vicinity of the windows.

In conclusion, Captain Stroud said that while it might be difficult to secure uniformity of action in regard to window-lighting in the streets, concerted action could easily be taken in connection with the lighting of exhibitions which was often faulty. Exhibitors might be allowed latitude to develop their ideas of lighting, but some simple rules for the avoidance of glare might be generally adopted.

Mr. E. C. Leachman, in dealing with "Illuminated Signs," expressed similar views in regard to the avoidance of glare. Masses of bright lights, operated by flashes, seemed often designed to startle rather than attract and probably made more enemies than friends. Signs of this nature had reached their greatest development in the States, but even in that country there was room for more scientific study of the subject. In luminous signs, as in show-window lighting, there was room for co-operation. Very frequently luminous advertisements were spoiled by the presence of brighter and larger ones that killed their effect. Mr. Leachman then proceeded to discuss various difficulties in connection with letter-signs, such as the fact that they might not appear equally legible when viewed from all directions, and the high maintenance and upkeep. He believed that the pictorial illuminated sign was more effective. Posters had been illuminated effectively in the States by flood-lighting methods, but it was not always possible to find a suitable place for the projector in order to get even lighting. If such areas were lighted by a row of concealed lamps slightly in front of the top edge of the device the brightness was in general far from uniform.

A more effective method was the illumination of pictures by the transmission of light from behind. In this way greater contrasts of brightness and darkness could be obtained, and signs illuminated from the front appeared flat in comparison. The cost of maintenance and energy for such signs was very much less than that of letter-signs composed of individual lamps. The quality of the pigment used was of great importance. By a recent discovery colours had been deposited on fine linen in such a way as to secure high translucency and brightness, with a great diminution in the cost of production.

Mr. Leachman pointed out that luminous signs had many fields of utility as well as for advertising, e.g., in indicating the numbers of houses, the names of streets, the positions of post offices, police stations and public buildings. There was a section of the public that resented the use of distasteful unduly brilliant signs which acted as a disfigurement. Some understanding should be arrived at by which signs could be used in a legitimate way and encouraged, with due regard to the effect on the safety of traffic and the general appearance of a city by night. Provided they presented surfaces of diffused brightness luminous signs would be welcomed, as they added considerably to the attractiveness of streets by night, and served as a useful supplement to public lighting.

Mr. Leachman also referred to the lighting of exhibitions, where co-ordination of effort was quite practicable. Suitable coloured signs could be used to mark out exhibitions into sections and enable visitors to find easily any stall they wanted. Here again masses of bright lights, which were wearisome to the eye, should be avoided. There was a great field for the skill of the illuminating engineer in spectacular lighting for outdoor exhibitions, which had been very imperfectly exploited as yet.

At the conclusion of his address, Mr. Leachman exhibited a number of striking transparency-signs, a feature of which was the brilliancy of colouring. A number of other types of signs were shown by other exhibitors, several of a most ingenious nature. Mr. Ruthven Murray showed some signs consisting of sheets of plate glass on the back of which lettering in white was stencilled. Tubular lamps concealed along the edge of the glass illuminated its interior so that the letters stood out brightly illuminated without the source being seen. Mr. Field showed a form of luminous kaleidoscopic sign, and Mr. Beuttell a form of sign utilising a curved white back-plate illuminated by lamps at one extremity. In this way illumination with comparatively few lamps was obtained, and stencilled letters placed in front appeared brightly illuminated.

Amongst others who joined in the discussion, Mr. Elliott described some of the devices used on the underground

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railways and illustrated an effective example of flood-lighting employed to display the name of the station at Sloane Square. Mr. Cunnington also referred to methods employed on the L.S.W. Railway, dwelling especially on the lighting of station name-plates, which presented several interesting problems.

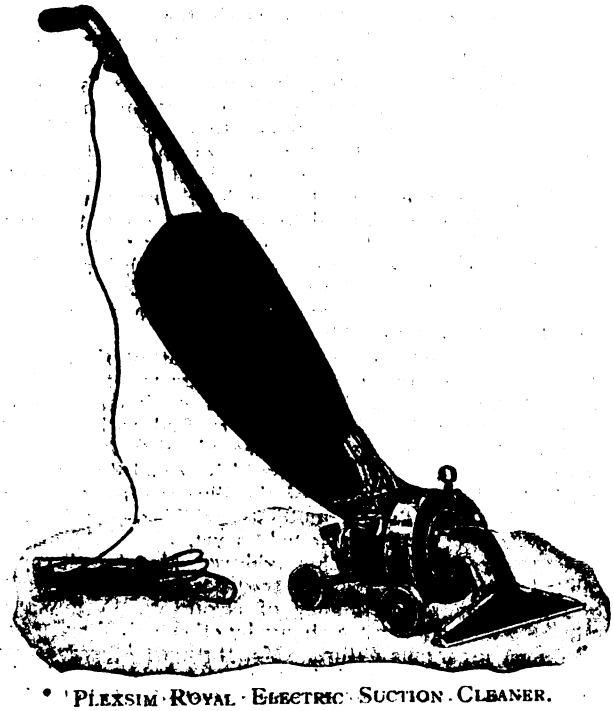
After a vote of thanks to authors and exhibitors, the Chairman (Mr. J. Eck) announced that the next meeting would be held on March 17, when there would be a discussion on motor-car headlights.

THE BRITISH INDUSTRIES FAIR, BIRMINGHAM.

BY A SPECIAL CORRESPONDENT.

(*Continued from page 131.*)

Quite a number of new lines are shown by Simplex Conduits, Ltd. (Birmingham and London). There is a lamp designed to comply with the new Mines Regulations Act, the simplicity and strength of the connections being noticeable, together with its gaslight and foolproof qualities. The base can be used as a two-way or four-way box. Another new device, shown for the first time, is a radiant heater, with a spun copper reflecting bowl, from the centre of which stands out the heating element. This can be connected up with any lamp-holder, and has a capacity of 600 watts. The heating element is nichrome wire, and through it is run an asbestos tape to prevent the sagging of the heating element, which stands out at right angles to the reflecting bowl. The whole thing is very portable and get-at-able, and sells at a low retail price. A new distributor board is designed to meet the Home Office requirements. A feature of it is the impossibility of touching any live metal parts. This is quite a water-



PLEXSIM ROYAL ELECTRIC SUCTION CLEANER.

tight job, and the board carries up to 15 amperes. A non-warping asbestos fillet is fitted below the fuse holders, and generally it is a simple, strong and practical piece of apparatus. The reliable Plexsim electric iron is also shown. The Company gives a life guarantee, i.e., the heating element will be replaced at any time free of charge, assuming, of course, that it fails under ordinary wear and tear. The iron is made only in the 5½ lb. size. The element is nichrome wire on mica, and is of flat construction. A fine display of electric lighting fittings includes a new "silver grey" fitting, for want of a better term. This has an appearance of polished aluminium, but yet not quite so brilliant. It gives an exceedingly rich-looking effect. The Plexsim Royal electric suction cleaner (see illustration) is also in evidence. It was described in ELECTRICITY for February 25, p. 122.

Gent and Co., Ltd., of Leicester, have a large display of electrically controlled time-pieces, which are made on what is called the Pulsynetic electric impulse system. The master transmitter on the stand controls the clocks in all the buildings. In addition to keeping all the clocks in an establishment showing the same time, time contacts can be added so as to sound "start work" and "cease work," these signals consisting of electric bells driven from service mains or batteries, electric or steam hooters or syrens. Quite an interesting feature is the apparatus for checking the time by wireless from the Eiffel Tower. In pre-war days the firm produced wireless sets fitted with crystal detectors for receiving Greenwich time by wireless. With the advent of the thermionic valve and the enormous advantages possessed by valves over crystal detectors, a "Tangent Radio" receiving set is now offered. This set eliminates the need of erecting a high aerial. Among the other items on this stand are a water-level recording instrument and secret intercommunication telephones.

Electric irons, fires, and heaters and cookers are shown by the Falkirk Iron Co., Ltd., of Glasgow and London. These have already received considerable notice in the electrical Press, and need not be referred to in detail now. Electric heaters and irons may also be seen on the stand of May and Padmore. These are only a small branch of the activities of this firm of brassfounders, etc., but the aim is quality, which is well reflected in the apparatus on view as well as in the display of electric light fittings. Indirect lighting, bowl pendants, find a prominent place, as indeed do they on all stands where electric lighting fittings are exhibited.

Intercommunication telephones are to be found on the stand of the Telephone Manufacturing Co., Ltd., of London. The most recent addition to this firm's output is the "Laryngaphone," an instrument for telephonic uses in aeroplanes, boiler-houses, etc., where the great amount of noise renders the ordinary telephone inefficient. The principle of this apparatus is that the vibrations from the larynx are transmitted through a "mouthpiece" held to the throat. Thus, by speaking in quite an ordinary tone, speech can be transmitted with the utmost clearness to the hearer.

Berry's Electric Ltd., of London, have a big show not only of the Magicoal electric fire, which has been a familiar figure at other recent exhibitions, but of interlocking switchgear and switches of the type that prevents the covers being removed whilst the contacts are in the "on" position. Similarly, if the cover is removed, it is impossible to replace it if the switch is "on." The contacts are so arranged that the fingers cannot in any circumstances come into touch with them. This principle is applied even in switchboads for quite large work, and a three-wire 500 volt D.C. board of this type is shown. On another type of board there is a carbon make-and-break before the main break-and-make, thus reducing the flash. The "Asku" lamp-shade tilter has the advantage that it removes the weight of the shade, lamp and holder, from the wiring terminals.

There are three exhibits of electric industrial trucks, viz., the "Orwell," made by Ransome, Sims and Jefferies, Ltd., Ipswich; the Drake and Gorham; and the "Greenbat," made by Greenwood and Batley, Ltd., of Leeds. Most of the features of these are now well known. Here again, foolproof devices are being added, so that, for instance, it is impossible for the truck to be started until the driver is actually sitting on the driving-seat. This is claimed as a special feature of the Drake and Gorham truck, which has been given the name of the Railodock. In the case of the "Greenbat," where there is no driving-seat, a pedal must be depressed before a start can be made,

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whilst if the driver falls off, the brakes automatically come into operation.

Ships' fittings of all kinds have always been the speciality of W. McGeoch and Co., Ltd., of Glasgow, Birmingham, and London, and examples of all kinds of such apparatus are shown. There are distributing boxes, terminal boxes, and switchgear for all kinds of ships' work, and the solidity of construction is sufficient evidence of the specialising effort that has been brought to bear on the firm's products. Probably nowhere is it more important to have foolproof apparatus than on board ship, and so we find a full application of the locking principle in the case of controlling switches, etc. A feature of the Duplex ship's signal lamp indicator is the warning given of any failure of the ship's signal lamps.

The Premier Electric Heating Co., Ltd., of Birmingham, show a specially "cut" line in the form of a 600 watt heater. It can be used, by changing the position, as a dish heater, a small electric fire for floor use, and also for toasting, boiling, and frying. This firm claims to have had a longer experience than any other, dating back to the time of the old Prometheus Co. Being specialists in this particular line, and touching nothing else, the output is of a strictly competitive nature, everything except the castings being made in the firm's own works. Quite a useful piece of apparatus under any conditions of varying voltages is a Universal iron, which will work on from 100 to 250 volt circuits. Ovens, fires, and cooking utensils with heating elements are also shown. The "Super-smoothwell" iron, latest model, marks a distinct advance on the old original "Smoothwell," the heating element being arranged to give greater heat at the point of the iron—the essential place. A patent cord-grip connector positively grips the flex and prevents any "pull" or strain.

The British Electric Co., Ltd., of London and Birmingham, show several quite new things in the way of accessories. The "Imperial" toaster is soundly constructed of steel and cast iron, and is fitted with a handle at the top. A pulpit or desk-lighting fitting keeps the glare from the lamp away from the eye by means of a cylindrical reflector. An improved type of ceiling rose, with a metal case, has been designed as a labour-saving device and can be used in place of the ordinary block and porcelain ceiling rose at very little extra cost. It is offered as a wiring accessory for the best class of electrical work. The base is made of a carefully tested and moulded non-hygroscopic material which forms a perfect insulator equal to vitreous porcelain, and is unbreakable in ordinary use. A new plug of the three-pin type requires a half turn to put it in or pull it out. Some very fine samples of switch plates are shown, as well as bowl fittings, inspection lamps, etc. Attention should also be drawn to the "Simfix," or one-part lamp-holder, the rapidity with which it can be wired being claimed as effecting a 50 per cent. saving in labour.

A large number of other firms exhibit electric light fittings of various designs, among whom may be mentioned British Brass Fittings, Ltd. (Birmingham); Ingram and Kemp, Ltd. (Birmingham); Sperryn and Co., Ltd. (Birmingham); Best and Lloyd, Ltd. (Birmingham); Osler's, Ltd. (Birmingham); Faraday and Son, Ltd. (London); Watertight Fittings, Ltd. (Chesterfield); Electric Heating and Hardware, Ltd. (Birmingham). No exhibition, of course, would now be complete without the "Rawlplug," which electrical contractors have found so useful, whilst there are a number of exhibits in which electricity is used in one form or another, such as the "Utility" electric floor-polishing machine shown by Parker, Winder, and Achurch, Ltd. (Birmingham), and automatic electric lighting equipment shown by the Austin Motor Co., Ltd. (Birmingham), and Mark Webber, Ltd. (Guildford). There are also certain applications of electric power in the heavy engineering section, on standard lines.

Among the lighting fittings exhibits, a novelty is the vitreosil ware made by the Thermal Syndicate, Ltd., of Wallsend-on-Tyne, which has special heat-resisting qualities, and can be exposed to rain, when hot, without fear of damage.

An exhibit of sentimental as well as practical interest is that of the Birmingham Training Committee, which has now 1,211 ex-Service men in training. One of the sections is armature winding, the scheme being to give twelve months' training in a technical school or instructional factory and six months in the workshop to attain proficiency. The various trades in which training is being given were shown in operation.

ELECTRICITY DISTRICTS.

A local inquiry is to be held at Leeds on April 12 with reference to the area to be included in the proposed West Riding (Aire and Calder) district. The following will also be considered:—(a) A scheme submitted by the Corporation of Leeds; (b) a scheme submitted by a conference of West Riding Local Authorities; and (c) proposals submitted by the Yorkshire E.P. Co. Copies of the respective schemes and proposals may be obtained (a) from Sir Robert Fox, Town Clerk, 11, Park Square, Leeds, at a cost of 5s. each; (b) from N. J. Fleming, Esq., Solicitor to the Conference of West Riding Authorities, Town Clerk's Office, Bradford, at a cost of 5s. each; (c) from the Secretary, the Yorkshire Electric Power Company, Wellington Road, Dewsbury, at a cost of 2s. 6d. each. Copies of technical particulars in support of the said schemes and proposals can also be obtained at a reasonable charge on application at the addresses stated prior to the date of the inquiry. Any representations or objections should be addressed to the Sec., Electricity Commission, Gwydyr House, Whitehall, London, S.W.1, before March 31, and a copy should at the same time be sent to Sir Robert Fox, N. J. Fleming, Esq., or the Sec., Yorkshire E.P. Co., as the case may be, at their addresses mentioned above.

The Commissioners will at the same time inquire into an application by the Yorkshire E.P. Co. for consent under Section 11 of the Electricity (Supply) Act, 1919, to the established by the Company of a new generating station at Ferrybridge (Pontefract).

The time within which objections and representations may be made, or alternative schemes submitted, has been extended in the case of the Mid-Lancs District until May 31, and in the case of the S.E. Lancs District until July 30.

ELECTRICAL EQUIPMENT FOR KINEMATOGRAPH THEATRES.

That electricity is essential for the successful conduct of a kinematograph theatre is common knowledge, but the fact that to meet the peculiar requirements the plant and its method of installation must be of the utmost simplicity, reliability and efficiency is not always appreciated as it should be. The various statutory rules and regulations have been framed for the safety of the public and of the operators, and are therefore for the good of the industry, so that for this reason alone no attempt should be made to evade any of them. Plant and apparatus should be purchased and installed by firms thoroughly conversant with the requirements. In this connection we are impressed by a recent publication issued by the Metropolitan-Vickers Electrical Co., Ltd. (Trafford Park, Manchester). It contains a list of between five and six hundred kinematograph theatres equipped with Metropolitan-Vickers apparatus, gives the statutory rules and orders, and explains concisely the conditions under which the public electric supply, if available, should be utilised, the use of motor-generator sets, gas and oil engine sets, the various types of control gear, etc.—all manufactured within the company's organisation. Nor are the questions of exterior and interior illumination and ventilation neglected.

The control gear differs in every individual case, and hardly any two theatres have exactly the same equipment, though generally speaking all are built on the same lines and modified to suit the special circumstances. For motor-generator sets the control gear consists of three units, one

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each for the motor, generator, and the bioscope; these can be either separate or combined to suit the design of the building. For gas-engine and oil-engine sets the motor unit is, of course, not required. In cases where the public electric supply is available it is now the usual practice also to install resistances, for use in emergency only, for operating the bioscope. This resistance can be placed in any convenient position such as a cellar or garret. Where theatres have a small lantern for projecting advertisements, announcements, etc., on to the screen, the bioscope panel is then equipped with the necessary apparatus to control this also.



FIG. 1.

A unit type D.C. motor panel, carrying a mechanically interlocked main switch and fuse box, with ammeter and starting rheostat for the motor, forms a very useful type of control. The generator panel is similar except that a field rheostat replaces the starter, and a voltmeter is generally provided as well as the ammeter. This type of panel is widely used where inexpensive and, at the same time, reliable control gear is desired. The switchgear is enclosed in dust-proof covers.

Fig. 1 shows a small panel for mounting in the operating box. This is equipped with ammeter, voltmeter, switch, fuses, and regulator for the bioscope arc, together with a field rheostat for the generator; the starting rheostat for the motor of the motor-generator set is also mounted at the foot of the panel, while the motor main switch and double-pole fuses are mounted separately. This type of switch panel is very convenient in a large number of cases. Attention is specially drawn to the fact that the field rheostat for the generator is, in this arrangement, mounted in the operating box. This feature enables the operator to have full control of the generator voltage from the operating box, which may be, and usually is, some considerable distance from the motor-generator set itself.

B.T.H. STAND AT THE EFFICIENCY EXHIBITION.

THE TIRRILL REGULATOR.

Those of our readers who were unable to visit the recent Efficiency Exhibition at Olympia may be interested in the illustration herewith of the stand of the B.T.H. Company. A thoroughly representative selection of the company's manufactures were shown (ELECTRICITY, February 11 and 18, pp. 91 and 105), and in the illustration the novel automatic arc welding machine may be seen on the right, the Tirrill regulator on the left, while various items of lighting equipment are well in evidence.

The Tirrill regulator is a satisfactory and reliable device for automatically and instantaneously regulating the voltage of either A.C. or D.C. generators. Tirrill regulators can be constructed either to maintain the busbar voltage constant or to compensate for line drop at some distant point in the system, and thereby maintain a constant voltage at that point. Or they may be used for holding a current constant, holding the speed of a motor constant, or controlling fly-wheel motor-generator set. Essentially the instrument consists of a differentially-wound relay magnet and a main control magnet, the terminals of which are connected to that part of the circuit where a constant voltage is to be maintained. The latter magnet has an adjustable core at the bottom, with a movable core above. The movable core is attached to a lever operating the main contacts, the pull being opposed by a spring which tends to keep the main contacts closed. The relay magnet has a U-shaped core, and its armature operates the contacts which open and close a shunt circuit across the field rheostat. One of the differential windings is permanently connected to the busbars or to some other convenient source of supply, and the other is connected to the same source of supply through the main contacts. The relay contacts which open and close the shunt circuit across the field rheostat are protected by a condenser of suitable capacity connected across them.



The following description of a complete cycle of operations will serve to explain this action:—

Assuming that the voltage has fallen, the instant it does so the current and the pull exerted by the control-magnet are reduced. The spring is then able to close the main contacts which complete the circuit of the right-hand relay coil. The current in this coil produces a flux which is equal and opposite in direction to the flux produced by the left-hand coil, which is always energised. One flux therefore neutralises the other, removing the magnetic pull on the relay lever or armature, so that the spring which is attached at once pulls the lever up and closes the relay contacts, thus short-circuiting the field rheostat. The current in the field immediately begins to rise at a very rapid rate, owing to the time-constant of the field circuit being kept very low, and the voltage also rises in a corresponding manner so as ultimately to reach its proper value.

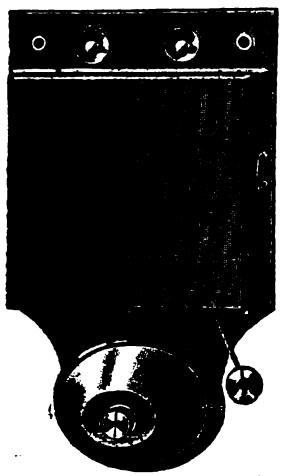
The voltage takes an appreciable time to rise to its full value, but almost instantaneously rises to a point where it causes sufficient current to flow in the control magnet to produce a pull strong enough to overcome the spring. The main contacts then immediately part, opening the circuit of the right-hand relay coil. The left-hand relay coil energises the core, and the relay armature is pulled down, opening the relay contacts, thus leaving the field rheostat, which is set to maintain only about 60 per cent. of the normal voltage, in series with the field. The voltage immediately commences to drop to this point, and, in doing so, almost instantaneously reaches a point when the main contacts again close, and another cycle is started. The rate at which these operations take place is very rapid, and is dependent upon the characteristics and sensitiveness of the generator. It also varies with the load, usually being less rapid at no-load and full-load than at intermediate loads. It is also dependent upon the point on the magnetisation curve at which the generator is working at the time.

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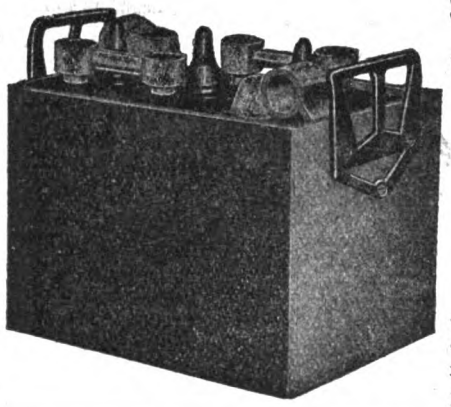
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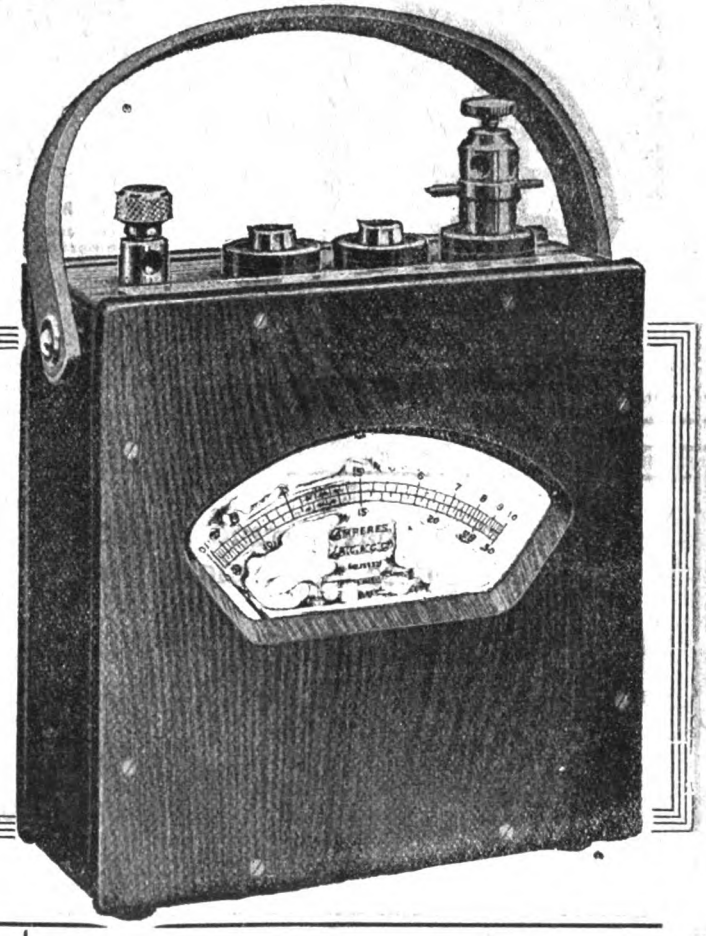
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

The present slump in industry, with its accompanying unemployment, is the theme of many speeches and addresses by leading employers throughout the country to-day, and the general trend of their advice, based on a keen practical knowledge of industrial affairs, is that we must jointly do our best to reach a stable condition of prices, wages, and cost of living before we can hope to compete with foreign interests and regain the bulk of the trade which we have already lost. Speaking at a recent Industrial League conference, Mr. Hugo Hirst, of the General Electric Company, referred to the difficulties of stabilising anything except the relations between employer and employed, and the conditions under which industry is carried on.

Stability.

In the first place they could not stablise the price of food, and consequently it was equally impossible to stabilise the price of other products. In regard to the production of any commodity, it was necessary to realise that they could not stabilise the raw materials, which were subject to the inexorable law of supply and demand. Mr. Hirst expressed the opinion that nothing would so easily bring about stability of industry as stability of conditions under which it is carried on. If an employer knew he had fixed a sliding scale to work upon, he could go ahead and make estimates; but, if he did not know, he could not make estimates; and, as a natural consequence, he either could not tender, or he had to hedge his tender round with conditions which rendered it impossible of acceptance.

He instanced how his company a few weeks back lost an order worth £150,000 from a Sheffield firm because their customer only had a certain sum of money available, and could not hope for further credit from the bank if it exceeded that sum. The only fixed and firm tender for the work was received from a German firm, as, under present conditions, no British concern could give a fixed price and an assured delivery. As a result the order, along with many others, had gone abroad. All engaged in industry must realise that they must produce cheaply, and jointly concentrate on how best to do so. The more articles they could bring within the purchasing scope of the largest number of buyers, the less likely they were to suffer from unemployment. As long as employment continued there were always men at work economising and introducing new inventions, which gave rise to new industries and created further employment.

It was only by applying skill and producing in such quantities as he had indicated that prosperity could be obtained. They not only wanted to produce cheaply for the purpose of having a larger clientele, but equally in order to purchase more cheaply. It was not commonly understood that the price at which they produced at home was the price at which they could buy abroad. The foreigner does not base his selling price to the British on his cost of production, but he quotes just a little cheaper rates than those ruling in the home market and fixed by producers of similar goods in this country.

Commenting on the present "ca' canny" methods in the building trades, Mr. Hirst also referred to the consequent delays in completing a new factory at Coventry. The contract was originally placed with a firm of most energetic builders, who promised completion within six months. That was twelve months ago, and the work is still uncompleted. These methods of the building trade may have the effect of keeping a few men employed over a longer period than if they worked whole-heartedly, but, as a consequence, in this particular case at all events, they were keeping thousands of men in other trades out of work because the factory was not ready to accommodate them. Had these new buildings been finished, the company would have been employing 2,500 skilled workers in addition, and orders would have been available to ensure steady employment for ultimately double that number.

Mr Bernard Drake's address to the London staff and employees of Messrs. Drake and Gorham was on similar lines. Since the Armistice a spirit of selfishness and grab had pervaded the country. Although the manual workers, with their 300 strikes, were most in evidence, shopkeepers and some employers were equally to blame. There had been a desire to get the most money for the least work, coupled with a craze for pleasure. The inevitable result had now taken place, and prices generally had reached a level where there were few buyers and consequent general unemployment. The futility of "ca' canny" and the way in which it reacts on those who employ these methods is now amply proved, and all must appreciate that prices of products of whatever kind have got to come down before unemployment will cease.

Following a short boom after the war, due to the fact that arrears had to be made good at any price, we have now got back to the laws of supply and demand, with competition from abroad. In dealing with the so-called struggle between Capital and Labour, Mr. Drake defined Capital as the accumulation of thrift, and stated that any worker who put by a few pounds for the benefit of his wife and children instead of wasting it on amusement became, in effect, a Capitalist. He added that it was now forty years



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since he started in the electrical trade. He was faced with the difficulty of working capital and credit, and for many years all his savings had been put back into the business, thereby enabling an ever-increasing staff to be employed.

The Birmingham Power Famine.

A serious handicap to further industrial development in Birmingham is the present inadequate supply of electrical energy. On the waiting list of the Corporation are requests totalling some 45,000 additional h.p., and it is estimated that 75 per cent. of the total energy produced at present is utilised for power purposes. To ease the situation it has been suggested that manufacturers in need of additional power should come forward and assist the Corporation to provide for their needs by advancing the money necessary to purchase additional plant, at 6 per cent. interest.

The chairman of the Electricity Supply Committee recently explained the scheme to the Chamber of Commerce. To place a contract as had been contemplated for two additional generating units would involve an expenditure of nearly 1¾ million. To install one unit would cost a little more than half this amount, and would probably meet immediate needs. Mr. Beale sketched the position when a trade revival came along. Seeing that it would take 2½ years to install further big electrical plant the work ought to be put in hand at once. By the subscription of one million the present waiting list could be accommodated, whilst the full amount mentioned would enable the Corporation to take on every would-be consumer. It was a reasonable proviso that everybody who subscribed should be entitled to power in direct ratio to the amount subscribed. According to report the proposal was not very sympathetically received by the Chamber, and Birmingham industry looks like suffering a power shortage for some considerable time to come.

Lighting as an Aid to Publicity.

The use of light as an aid to publicity, which formed the subject of discussion before the Illuminating Engineering Society on February 24, proved to be quite a complex subject. We have frequently heard the claims of light in this direction emphasised by makers of luminous signs and lighting appliances. On the other hand, protests have been raised by other sections of the public against the disfigurement which over-brilliant flashing signs are apt to involve. Captain Stroud, who dealt with show-window lighting, and Mr. Leachman, who discussed luminous signs, both dealt with their subjects in a broad and tolerant way.

Captain Stroud advocated the use of concealed lighting, now generally accepted by lighting experts and managers of large stores for window lighting, and pointed out the drawbacks of displays of bright unscreened lamps in or adjacent to windows. Mr. Leachman confessed that some signs seemed designed rather to startle than attract, and advocated more artistic display methods of the illuminated pictorial variety. Judicially used, such lighting, whether in the form of illuminated signs or lighted shop windows, acts as a useful supplement to public lighting, from lamps necessarily spaced wide apart and casting sharp shadows.

The problem is to attain some form of concerted action in the interests both of the advertiser and the public. A well-designed and nicely-lighted window may be completely "killed" by masses of bright lights used by a neighbour. Similarly, quite a tasteful and effective luminous sign may be lost amidst much brighter ones adjacent to it. In regard to public streets we must apparently trust chiefly to the change in opinion of merchants and advertisers through such discussions as this, aided by judicious influence of local authorities But, as was pointed out by both authors, concerted action is much easier in exhibitions, and there is no reason why a few salutary rules should not be adopted whereby both the interests of exhibitors and the eyes of visitors to the exhibition would be safeguarded.

Keeping Capital Within the Empire.

There is much to be said for the policy of investing our capital practically entirely in productive enterprises within the Empire, as is advocated by the British Empire Producers' Organisation. On the other hand, I do not agree that the policy of permitting public appeals for capital in this country on behalf of foreign governments and municipalities as was general before the war is "suicidal." For one reason, all consumers have suffered owing to the terrific rise in prices, largely brought about by the neck-and-neck race between the "workers" and "capitalists" for increased remuneration the moment foreign competition dwindled. My faith in our much-vaunted "patriotism" is considerably shaken by the way our countrymen with the power fleeced those without power the moment they saw the chance to do so.

ELEKTRON.

THE INSTITUTION DINNER.

Mr. Ll. B. Atkinson, who is proving a very live and energetic president, took the chair at the annual dinner of the Institution of Electrical Engineers at the Hotel Cecil, on Thursday, 3rd inst., when there were about 450 members and guests present to give him their warmest and most cordial support. Prior to the dinner there was a reception in the adjoining hall, but this unfortunately was not nearly large enough, and movement was a matter of difficulty, due to the fact that the large (or Victoria) hall, which was used for the reception in pre-war days, was on this occasion booked for another function. The cloak-room arrangements, also, leave room for improvement, but these troubles will doubtless disappear as time goes on. The dinner was a good one, and, after the usual loyal toasts and the announcement by the president of the receipt of telegrams of congratulation from kindred societies in Italy and the United States—duly acknowledged forthwith—Professor Sir W. H. Bragg, K.B.E., F.R.S., president of the Physical Society, proposed the toast of "The Institution" in a very felicitous speech, in which he alluded to the triumphs of electrical engineering in the past, and looked forward even more hopefully to its future, as electricity

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might be said to lie at the root of all natural phenomena. In fact, our problems brought physicists some of their most interesting work. He thought our Institution represented a very high ideal, and said how much it had encouraged men to learn their work thoroughly, thereby leading them to help mankind and their country. The only way for us to get on is to give of our best without seeking a return, and we must not try to see what we have to receive, but look at what we have to give. Really to think with more love of our work than of our pay. He considered that was exactly what the Institution of Electrical Engineers was doing, and then went on to speak of the president in terms of high praise. Needless to say, the toast was received with great enthusiasm. Mr. Atkinson then replied with one of those clearly spoken and incisive speeches of which he is such a master, including humorous references to Sir Oswald Stoll and the two-houses-nightly system. He told us that the Institution was now 9,400 strong, that it was associated with 14 committees connected with public work, as well as being represented on, or taking part in, the proceedings of 40 kinds of external bodies. In two months they had had 47 meetings and discussions, and the hard work done by the Institution was in the long run bound to have a good effect on the profession and the industry. He then gave a most interesting résumé of the causes and effect of the trade slump, with keen analysis of the financial position, and finally finished up in a more hopeful strain so as to cheer us all up. Mr. Campbell Swinton proposed "The Guests," and replies were made by Sir Frank Heath, K.C.B., and Sir John Bland-Sutton, both of whom dealt in a humorous strain with various past experiences, and the gathering then dispersed to the reception room for more friendly discussions and reunions. Space does not permit us to give the names of all the distinguished visitors who were present, but the top table represented Imperial Science, Commerce and Government in a very adequate manner. Altogether a splendid evening.

THE KING'S SPEECH AND UNEMPLOYMENT.

THE RIGHT HON. G. N. BARNES ON THE ATTITUDE OF LABOUR.

More and more of late has it become increasingly evident that if the unemployment problem is to be solved it will only be through the co-operation of the two essential factors in industry, namely, employer and employed, or, as the King has put it, Capital and Labour.

The King, in his speech at the opening of Parliament, after alluding to the measure it was the intention of the Government to introduce relative to unemployment, said:—

> "I earnestly trust that these efforts will be seconded by loyal and frank co-operation between employers and employed, for it is through the co-operation of Capital and Labour in a spirit of mutual trust and confidence that an early solution of this grave problem is to be found."

The Prince of Wales recently struck the same chord when he appealed to all to "pull together." Lord Weir and other prominent men have propounded the same principle. It has come alike from all sections of industry, so it is but fitting that it should have received a stimulus from the Throne.

The attitude of official Labour, however, is in many respects problematical, and the Right Hon. G. N. Barnes, M.P., in the course of an interview on the subject, said: "The Government have committed themselves through the King's speech to the principle of co-operation between all classes in industry so as to get the best results. For my part I am glad of that, because co-operation, good at any time, is especially desirable just now when the world is torn to pieces by the war.

"It is a principle which was inculcated during the war and realised by Labour leaders at the time. It is a principle which led my old colleague, the Right Hon. G. H. Roberts, in 1915, when he was Junior Lord of the Treasury, to help found the Industrial League and Council, and the King has now endorsed the ideal which that organisation has for years been propagating with pronounced success.

"I am sorry that the Labour Party did not avail itself of the opportunity that was opened to it on Christmas Day to co-operate with the Government in devising ways and means to minimise the evil of unemployment. I think possibly if that had been done, there would have been an expediting of relief work, and, generally speaking, help given to the unemployed in kind or in work more than has been done.

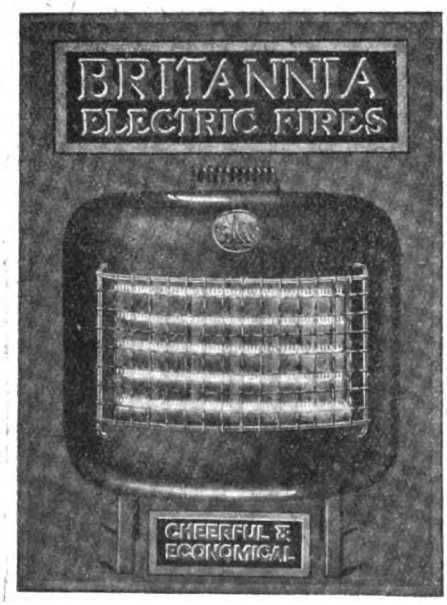
"The Labour Party chooses rather to play the part of the critic. It is the easiest part, but what we want just now is construction, and one fails to find much in the way of construction, or even in the way of facing the facts on the part of those who ought to be leading.

"I hope still that the principle incorporated in the King's speech may yet be put into operation by all those who really have the interests of the unemployed at heart."

BRITANNIA ELECTRIC FIRES.

NOVEL PUBLICITY DEVICE.

We illustrate an attractive coloured showcard novelty which is being issued by English Electric and Siemens Supplies, Ltd. (Brook House, 191-2, Tottenham Court Road, W.1). The showcard represents a full-size 1 kw. model Britannia Electric Fire and is made up from a combination of papier maché, cardboard and transparencies.



When illuminated by means of a 30-watt metal filament lamp, carried in a box fixed at the back, it reproduces exactly the glowing effect obtained from the Britannia Fire elements and should stimulate great public interest when displayed in the show window. A flasher could be introduced if it is desired to obtain an intermittent effect.

It will be appreciated that this showcard is not overcrowded with display matter but is most distinctive. Electrical contractors and dealers interested in the sale of electric fires should lose no time in applying for one of these devices, which are really much more than a "showcard." The whole device folds flat to facilitate despatch.

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ELECTRONS.

By SIR WILLIAM BRAGG, K.B.E., F.R.S.

(*Continued from page* 126.)

Exactly how this strange transfer of energy from one form to another takes place we do not know: the question is full of puzzles. The magnitudes involved are hard to realise; it helps if we alter their scale of presentment. Suppose that the target of the X-ray bulb were magnified in size until it was as great as the moon's disc—that is to say, about a 100 million times. The atoms would then be spheres a centimetre or so in diameter. But the electrons would still be invisible to the naked eye. The distance from earth to moon would correspond roughly to the distance that ordinarily separates the bulb from an observer or his apparatus. We now shoot electrons at the moon with a certain velocity: let us say that in every second each square yard or square foot or square inch, it does not matter which, received an electron. A radiation now starts away from the moon which immediately manifests itself (there is no other manifestation whatever) by causing electrons to spring out of bodies on which it falls. They leap out from the earth, here one and there one; from each square mile of sea or land, one a second or thereabouts. They may have various speeds, but none exceed, though some will just reach, the velocity of the original electrons that were fired at the moon. That, reduced again to normal size, is the process that goes on in and about the X-ray bulb: which is part of a universal natural process going on wherever radiation, electron or wave, falls on matter, and which is clearly one of the most important and most fundamental operations in the material world.

Keeping these results in mind, we can now appreciate a very remarkable development of the electron theory which has been made in the last few years. Spectrum analysis has long been occupied with the extraordinary complications of the radiation emitted by the various atoms. As a result it appears that the frequencies of the lines in a spectrum often display curious and exact numerical relations, in the form generally involving differences of frequencies of similar lines or groups of lines. For instance, the famous Balmer equation

$$\text{Frequency} = \nu = N\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right), \text{ where } N = 3{\cdot}290 \times 10^{15}$$

gives the frequencies of series of lines in the hydrogen spectrum. When n_1 is put equal to 2, and n_2 to 3, 4, 5 in succession, the series of values for ν represent the frequencies of the lines in the visible spectrum. If $n_1 = 3$ and $n_2 = 4, 5, 6, \ldots$, in succession, we have the frequencies of lines in the infra-red (Paschen) and if $n_1 = 1$, $n_2 = 2, 3, 4, \ldots$, we have the frequencies recently shown by Lyman to exist in the ultra-violet.

Now, there is nothing in our older conception of the origin of radiation within the atom to give us a clue as to why differences of frequencies should come into these empirical though most useful formula. We have pictured to ourselves vibrating systems, mechanical or electric, and waves arising therefrom. But what connection between masses or electricities gives us in any simple way equations involving the addition or subtracting of frequencies? We are in a blind alley. Let us, therefore, abandon our preconceptions as to the origin of those lines which we find in the light spectrum and suppose that here also they arise in the same fashion as we actually know that they arise in the cases we have considered above. Suppose that the energy of an emission of radiation is derived from the energy of an electron. It may be the only way in which radiation ever does arise, but it is not necessary to suppose so much at present. It is enough that we carry into the atom the whole process which in X-rays and the photo-electric effect we have observed to take place in part outside. Suppose that within the atom there are certain positions or conditions in which electrons *may* be, each postulating a certain energy content for the electron; and suppose that sometimes an electron slips from one position to another of lower energy, and that the difference in energies is transformed into wave radiation according to the same law as before, i.e., energy transferred = $h \times$ frequency. Let the energy in these states be $Nh1$; $Nh/2^2$; $Nh/3^2$; etc., and so on. Then Balmer's equation is accounted for and the other series at the same time, and also the peculiar form of these equations.

What may these states be? Why not, as Bohr suggests, so many different orbits in which electrons can move round the central positive nucleus in the atom, the nucleus whose sure existence Rutherford has established? At one time if we had presumed the existence of these orbits we should have been inclined to connect them with the direct emission of radiation, and the frequency of that radiation would be the number of revolutions in a second. But now, we assume these orbits to persist without radiation, and that radiation arises where the electron steps from one orbit to another: moreover, the frequency of the issuing radiation is determined by the simple rule, frequency is equal to change of electron energy divided by h. We are not picturing any new process here, or evolving new ideas to fit awkward facts; we are supposing a process to exist in one place which we already know to exist in another.

(*To be continued.*)

AN ELECTRICALLY CHARGED WATER PIPE IN CONCRETE BUILDING.

Some time ago the attention of the writer was called to a case of wiring trouble which produced an effect that was quite misleading. The trouble was reported by a printer, who complained that his water pipes were charged with electricity, and that every time he touched the water faucet in his plant he received a shock. When the inspector of the central station company started to investigate the trouble he found the printer's statement as to the shock to be correct. It did not seem reasonable, however, that the faucet, connected to an underground water system by a metal pipe, should be at a potential sufficiently high to give a person an electric shock. It was reasoned that it was more likely that the floor on which the person was standing when the shock was experienced was at a potential above the ground, and that the source of the stray current was in the floor.

The printing shop was in the second story of the building, which was constructed with a floor of reinforced concrete with the wiring for the first floor installed in iron conduit laid in the floor. A live wire

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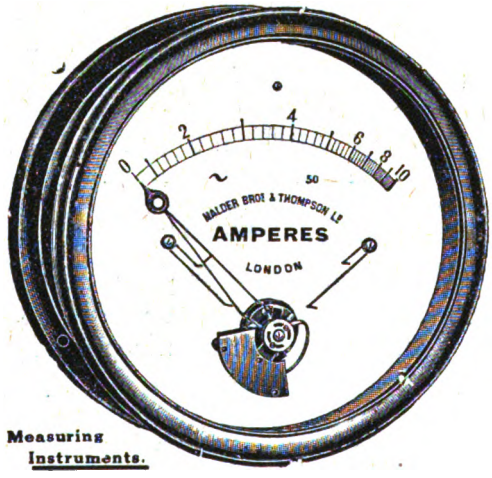
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of the 100-volt grounded lighting circuit had come in contact with the iron conduit, which in turn carried the current to the damp concrete floor under the faucet and raised the floor to a potential of 110-volts above the ground potential of the pipe. When the insulation of the lighting circuit was restored the apparent charge on the faucet disappeared.—*Electrical Review*, Chicago.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

The local Advisory Committee of Newcastle and district organised a dance in aid of the funds of this Institution, which was held at the Grand Assembly Rooms, Newcastle-on-Tyne, on Friday, February 25, 1921. The result was a most successful event, more than 350 tickets having been sold and about 270 guests being present at the ball. It is hoped that, as a result, the sum of about £100 will be added to the funds of the Institution. The electric lighting had been specially arranged by the General Electric Company, Messrs. Fletcher Bros., and Messrs. Robson and Coleman, and in the course of the evening various effects, probably novel in a ballroom, were produced by means of searchlights, one of the best of these being that of falling snow.

SUPPLY OF ELECTRICAL POWER TO INDUSTRIAL WORKS,

WITH SPECIAL REFERENCE TO THE DESIGN OF SUB-STATIONS.*

BY A. P. ROBERTSON, A.M.I.E.E.

(*Continued from page 125.*)

The transformers must be strongly designed to withstand short circuits which may come on due to faults in the rotary or to outside sources. The terminals should be easily accessible for changing taps or for inspection and cleaning, and no exposed metal parts should be allowed. The insulators should be easily cleaned and a dust-proof cover should be fitted over all. A thermometer pocket should be fitted to enable the temperature to be watched, as this is the capacity limiting factor.

The tanks should be strong and able to withstand rough handling. Although in the station shown, they can be moved fairly easily, yet sometimes they have to be moved by means of jacks and levers, and must be made strong enough for this.

The remarks on oil for switches apply equally here, but the sludging propensities should be a minimum.

The transformers ought to be inspected at least once a year, and a sample of oil drawn from the top and bottom of the tank and tested for moisture and insulation.

Rotaries may be either tap-started or self-synchonising. The tap-started rotary is run up to speed on a smaller voltage of the transformer obtained by tapping the low tension winding and is usually ¼, ½, or ¾ of the full voltage.

For this purpose, an oil-immersed controller is required. On switching to the first position, the machine runs up to speed, and if the polarity is correct the controller is brought over to the running position, thus putting full voltage on the armature. The controller requires examination frequently, and there is a considerable burning away of contacts, making the upkeep high in proportion to that required for the self-synchronising rotary, which is run up to speed by a separate motor mounted on an extension of the armature shaft.

The switchgear required for this is simpler and has practically no upkeep expenses. It consists of a triple pole starting switch for the motor and main switch with an indicator to show when the machine is in synchronism. These switches are ordinary air-break knife switches and should have insulating baffles fitted between the phases to prevent a flash over if they are drawn with load on. It is best, however, never to open these switches alive, but to do all switching out on the high tension oil-immersed switch and open the starting switch when the machine has stopped.

The rotary converter is a rotating machine which converts the alternating current into direct current at one operation and is distinguished from a motor generator in that there is a direct connection from the A.C. to the D.C. side. In a motor generator this is not the case. A motor

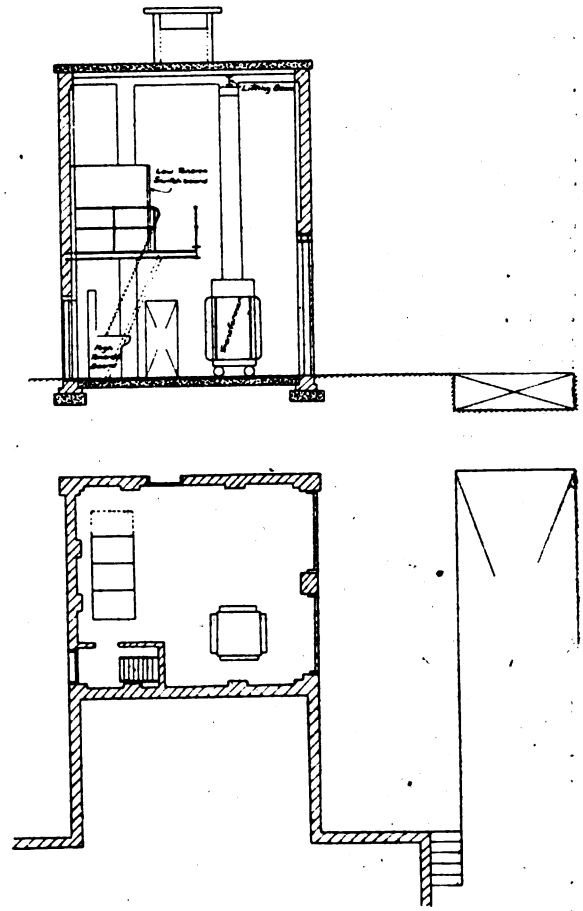


FIG. 2.

generally consists of an A.C. motor driving a D.C. generator, and the motor could be just as well replaced with any other prime mover.

The rotary is more efficient and is more robust, the efficiency being about 95 per cent. for a rotary and 90 per cent. for a motor generator. There is no high pressure on any of the windings, as the pressure is reduced in the transformer, and as this is immersed in an oil tank, the mechanical protection and insulation are better. Unless in very small sizes the motor of the motor generator generally takes its supply from the high tension busbars direct.

The rotary should be fitted with an overspeed device in case of failure of the D.C. field, or any other cause raising the speed dangerously high. This should cut out the D.C. side of the machine only. It is good practice to fit an oscillating gear to move the armature and rotating parts longitudinally. This prevents the slip rings and com-

*Paper read to the Royal Technical College Scientific Society, Glasgow, December 4, 1920.—Reprinted from *The Channel*, January, 1921.

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mutator from ridging. There are many means of effecting this end, some electrical and some mechanical, but one of the simplest consists of a ball running in a cup fixed on the end of one of the bearings. This is set at a very slight angle to the shaft, and the ball runs against a hardened steel plate on the end of the shaft. The cup is kept pressed against the ball by means of a spring, whose compression can be adjusted by means of a screw. The friction causes the ball to run round with the shaft, and as it rises it pushes the shaft away. When it gets to the top of its travel it falls to the bottom and the shaft is allowed to come back, being pulled into position again by the field strength. The amount of movement and periodicity can be adjusted also by means of a screw which moves the cup nearer or farther away from the end of the shaft.

D.C. SWITCHBOARD.

The D.C. switchboard consists of machine control panels and feeder panels. The machine control panels are fitted with circuit breakers fitted with overload and reverse current protection. The positive and negative panels may be close together with a coupling bar between the circuit breakers, so that both of the breakers trip simultaneously, and if this is the case, the connecting bar must be insulated, as in the event of it becoming alive it might cause a short circuit between the positive and negative breakers. An insulating baffle plate should also be fitted between the circuit breakers to prevent a flash over if they should open on a heavy current.

The relay should be a separate instrument from the circuit breaker and a very good type is one worked from the ammeter shunt. This can be arranged for both overload and reverse current. Two single pole knife switches should be fitted in series with the circuit breakers and the paralleling should be performed on one of these switches. This gives protection if anything should go wrong at the moment the switch is closed.

An ammeter is fitted on each side of the system so as to give an indication of the out of balance current.

The bus bars are large and rigidly supported on porcelain insulators mounted on angle iron stays and the whole framework is stayed to the wall by these angle irons. The panels are black enamelled slate 2 in. thick with bevelled edges. The feeder panels consist of a knife switch for each pole and fuses to protect the feeders. These fuses are set according to the load on the feeder during a period and are strengthened or lightened as necessity arises.

A recorder is fitted in each feeder so that a record of the load is kept at all times. This recorder shows both the amperes and volts on each feeder and is driven either by a clock contained in the case or by a relay worked from a master clock.

All potential wires are fitted with fuses as near as possible to the live end and these fuses are easily replaceable. The switchboard is 6 ft. 6 in. from the wall, thus allowing the rheostats to be placed directly at the back and still leave ample room for a man to get past without touching any live metal.

A static sub-station which contains no moving machinery is shown on figure 2.

(To be continued).

Trade Notes.

Siemens Bros. & Co., Ltd. (Woolwich, S.E.18) have issued a 4-pp. supplement to Catalogue 532. It deals with cab-tyre sheathed cables and flexibles.

The B.E. Co. (of London and Birmingham), Ltd. (Hendon House, 57, Upper Thames Street, E.C.4) have just issued a revised edition of the folder giving current prices of the items listed in their Accessories Catalogue. It will be remembered that there is a little pocket on the inside of the back cover for this folder, which is revised periodically.

One of the vital problems that have confronted tool makers, machine builders and mechanical engineers for years, is the lack of a practical tool for boring a square hole in metal, wood and other substances. How this has been solved by the **Lanston Monotype Corporation, Ltd.** (43 and 43a, Fetter Lane, E.C.4) is described in an illustrated booklet recently issued. The design of the tool is such that one operation only is required, and no handwork being necessary, the cost is reduced to a minimum.

The March issue of the monthly magazine of **Higgs Bros.** (Sand Pits, Birmingham) is, if anything, more screamingly funny than ever, while it is also of interest to all business men for the list of motors and dynamos in stock, which may be supplied at prompt notice. There are also some very practical hints and tips, in this instance on the choice of supply, while the great accident insurance offer referred to on page 5 of cover is sure to attract attention from a wide circle. The free gift also is something worth having! For further particulars, write the firm asking for a copy. It is worth while.

The "Electrolux" Suction Cleaner (**Z-Electric Lamp & Supplies Co., Ltd.**, 73, Newman St., W.1) has obtained for the manufacturers the Certificate of the Institute of Hygiene (Inc.) and in the "Transactions," a report on its construction and a reference to tests carried out is given. Contractors and dealers who have not yet investigated the "Electrolux," to which we have on previous occasions referred, might now, perhaps, give it careful consideration.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 113.

I have received advice to fit magnetic clutches in my machine shop instead of the fast and loose pulleys so necessary for machine operation. Can any reader tell me how these are operated, and what type of clutches I shall require? My lighting voltage is 230 volts.—"PLANER."

QUESTION NO. 114.

What are the advantages of shunt motors over series motors for lift operation, or *vice versa*? I am fitting shunt motors to some lifts in the works where I am employed, these being already on hand. Can any reader give me some practical hints concerning operation, controllers, limit gear, etc.?—"FLOOR."

(Replies to Questions Nos. 113 and 114 must be received not later than March 26, 1921.)

"The Mexican Review."—The February issue of "The Mexican Review," of Washington, D.C., U.S.A., is, as usual, full of interesting matter relating to the commercial progress of this great country, and it will appeal to all who have business relations with it. There is no doubt that Mexico is again becoming stabilised, and it should be part of the duty of all enterprising exporters to push English goods therein as much as possible, more particularly in view of the enormous amount of British capital which is already invested in the country. Copies of the paper may be obtained from the office at Room 501, 817, Fourteenth Street, Washington, D.C., U.S.A. The annual subscription is 15s. prepaid.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.

ELECTRIFICATION OF RAILWAYS. By H. F. Trewman. 78 pp. 13 figs. (Pitman. 2s. 6d. net.)—Considering the small size of the publication, it is wonderful what a truly impressive amount of valuable information is here presented. Moreover, the general arrangement and the author's easy style will appeal to electrical engineers interested in traction work as well as to others connected with railways and to the large number who, for various reasons, take an interest in railways and railway working. This book clashes with no existing ones as regards technical considerations, and at the same time deals fairly fully with commercial considerations—especially important now that the electrification of railways is being glibly talked about as though it could be accomplished by a stroke of the pen. In Chapter 1. the author sets out the main lines of investigation to be pursued in the choice of a site for a power-house and follows it up in succeeding chapters by indicating the various sides of the problem which require to be so treated. Without going into details it can be said that the whole question of railway electrification is touched on and all important matters dealt with. Possibly in some minor matters experts may differ, but in broad outline there is nothing whatever to which exception can be taken. The book is clearly printed in a large type and is one of Pitman's new Technical Primer Series.

ELECTRICIAN'S HANDY BOOK. By T. O'Conor Sloane, 824 pp. 600 figs. (Frowde, Hodder and Stoughton. 27s. 6d. net.)—The price is not the only bar to an extended sale of this book, which has now reached its fifth edition. It is something of a résumé of electrical engineering from earliest times when electricity became available commercially, and of an electrical handbook. It fails, however, in that the information is not nearly complete enough for practical purposes and the revision effected in an effort to bring it more or less up-to-date is far from thorough, and, at the same time, no indication is given as to what is obsolete and what is more nearly current practice. It is a pity, too, that the new matter has in most, if not all, cases been added in separate chapters at the end of the book, *e.g.*, there are two chapters on electric lamps of the more recent types, the original chapters being retained without alteration or cross reference. As for traction, anyone relying on this book for information would obtain the opinion that the best the electrical engineer had been able to do was to build a tramcar for 600 volts D.C. Finally it may be said that the mathematical section is not wanted, while the chapters on electric quantity and current, the electric circuit, "Ohm's law" and electro-chemistry, though not exactly inaccurate, are most difficult of comprehension. Too much is made of "Ohm's law" throughout the book and in spite of verbosity it is not correctly stated. The "Electrician's Handy Book" is described as a reference book for the advanced electrician and a text-book for the student. In the present state of our knowledge it is neither.

INSTITUTION OF PRODUCTION ENGINEERS.

At a meeting held at Cannon Street Hotel, London, on Saturday, the 26th ult., it was decided to form an Institution of Production Engineers. There was a large attendance when Mr. Honer, the convener of the meeting, opened the proceedings, and Mr. Cecil F. Hammond, of Coventry, was elected to the chair.

During an animated discussion affiliation with some other body was suggested; this scheme, however, did not meet with general approval, and it was ultimately decided by a large majority to proceed with the formation of a separate Institution. A representative committee was appointed to draft rules, etc., and to report progress at a general meeting to be held on April 2, the venue of which will be notified later. In the meantime it is requested that all interested, particularly those who wish to become members, will communicate with the Hon. Sec., Mr. A. T. Davey, 6, St. James's Square, Holland Park, Kensington, W.11.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

The Birmingham and District Electric Club held their annual dinner at the Grand Hotel, on Friday, March 4, when about 100 members and friends enjoyed an excellent dinner and musical evening. Mr. H. C. Wynne, the president of the club, occupied the chair, and in response to the toast of the City of Birmingham, Mr. P. H. Chattock, chief of the Corporation Electric Supply Dept., expressed his confidence in the future of electric supply in the city, notwithstanding the present financial stringency which had delayed their projected extensions.

Various Items.

Social.—The members of the Victoria Works Athletic Club (Messrs. Johnson & Phillips, Ltd., Charlton, London, S.E.) held their Annual Dinner on Saturday, the 5th inst., in the Club-Rooms attached to the Works. The chair was occupied by the President, Mr. H. J. Sheppard, General Manager of the firm, supported by the Vice-Presidents (Departmental Managers). After dinner the usual toasts were given, with a concert following, the artistes all being members of the club and firm. A very enjoyable evening was spent.

Smoking Concert.—The Inst.E.E. Informal Section gave a most successful Smoking Concert on Monday, February 28, at Anderton's Hotel, Fleet Street. Mr. W. E. Bradshaw and his orchestra were working devotedly most of the evening and were highly appreciated. Individuals of the Orchestra also gave solos; Mr. Le Roy with baritone songs, Mr. Hunt violin solos, and Mr. R. Christmas a most dexterous effort, "The Ragtime Bass Player." Mr. Gill's tenor songs were encored, and Mr. Callieu and Mr. Harry Hearne provided some excellent humorous items. An unexpected treat was the conjuring display of Mr. Jardine Ellis, who was in the building and kindly gave two short shows of his skill. Mr. F. Pooley was in the chair and, except when he was making a touching reference to the loss sustained by the Informal Section and engineering generally through the death of Mr. Rankin, all went merry as a marriage bell.

Meetings.—The Inst.E.E. will hold an Informal Meeting on Monday, 14th inst., at the Chartered Institute of Patent Agents, Staple Inn Buildings, Holborn, W.C., at 7 p.m. Discussion on "Large Mercury Arc Rectifiers," to be opened by Mr. R. L. Morrison.——A Wireless Section Meeting will be held at the Inst. of Mechanical Engineers, Storey's Gate, Westminster, S.W., on Wednesday, 16th inst., at 6 p.m., when the following papers will be read and discussed: "On the Effect of Electron Omission on the Temperature of the Filament and Anode of a Thermionic Valve," by Mr. G. Stead, M.A. "On some Thermionic Tube Circuits for Relaying and Measuring," by Miss W. A. Layshon and Dr. W. H. Eccles.——The next Ordinary Meeting will be held at the Inst.C.E., Great George Street, Westminster, S.W., on Thursday, 17th inst., at 6 p.m. Paper: "The Long-distance Telephone System of the United Kingdom," by Sir William Noble.——The Junior Inst. of Engineers will meet on Friday, 11th inst., at 39, Victoria St., at 7.30 p.m. Lecturette: "Electrical Drive in the Cotton Trade," by A. T. McGuire (Member). Slides. Also on Friday, 18th inst., at Caxton Hall, at 8 p.m. Paper: "Hand Operated Appliances for Lifting and Transporting, with particular reference to application in awkward circumstances," by T. E. Dimbleby. Slides. And on Friday, 1st April, at 39, Victoria St., at 7.30. Lecturette: "Pneumatic Conveyors," by Mark Jennings.

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The Electro-Harmonic Society.—The next smoking concert will be held in the Great Hall, Cannon Street Hotel, on Friday, (to-night) 11th inst., at 8 p.m.

Change of Telephone Number.—The telephone number of Automatic & Electric Furnaces, Ltd., 281-283, Gray's Inn Road, London, W.C.1, is now Museum 4187.

Glasgow.—The manager of the tramways service has been asked by the Committee on Extensions to consider the advisability of utilising trackless trolly-cars in certain districts.

Burnley.—The Watch Committee have refused a request that all electric and cinema plant at places of [illegible]ement should be in charge of competent electricians. The request came from the Electrical Trades Union.

Personal.—Mr. Harold E Mortimer, A.M.I.E.E., has resigned his position as Contracts Engineer with Messrs. Edmundsons Electricity Corporation, Ltd., and has joined the Board of Directors of Messrs. Baxter and Caunter, Ltd., 219, Tottenham Court Road, W.1.

Belgian Congo.—Extensive railway developments are about to be undertaken here, and as this necessarily opens up a demand for various electrical appliances, manufacturers should keep an eye on the colony. The B.O.T. Dept. of Overseas Trade will supply the latest information.

Personal.—Mr. A. G. Perring, has been appointed representative in the Birmingham district, for Messrs. H. W. Smith & Co., Ltd., cable manufacturers, of Lydbrook, Glos. His address is: Unity Place, 14, Temple Street, Birmingham. Telephone No.: Birmingham Central 2159.

Birmingham and District Electric Club.—The next monthly meeting will be held at the Grand Hotel, Colmore Row, Birmingham, on Sat., March 12, at 7 p.m. A paper will be read by Mr. H. C. Young, A.M.I.E.E., on "Common-Sense Methods of Recording Costing and Progress in Shop Management."

Northampton.—The E.L.& P. Co., Ltd., is paying a final dividend of 5½ per cent., making, with the interim dividend already paid, 8 per cent. for the year, compared with 7 per cent. for the previous year. The Rushden and District E.S. Co., Ltd., is paying 4 per cent., making with the interim dividend 6½ per cent. for the year.

Brazilian Customs Tariff.—The British Chamber of Commerce of Sao Paulo and Southern Brazil has arranged for the Brazilian Customs Tariff to be printed in English, Portuguese, French and Italian in one complete volume. A step which will prove of value to exporters to Brazil. The price will be 20$000 (twenty milréis).

S.S. "Somersetshire."—The steamer "Somersetshire," which has just been launched at the Queen's Island, Belfast (Messrs. Harland and Wolff's), is electrically fitted in every way. Her auxilliary engines, windlass, winches, patent steering gear, etc., will be electrically controlled, and the lighting will be of the latest and most powerful type.

Preston.—The T.C., on Feb. 24, agreed to the purchase of the National Electric Supply Co.'s undertaking, the total cost of which, it was stated, would reach £286,000. Ald. Margerison said the undertaking had been valued by a representative of the Electric Power Co., on whose figures they were justified in paying the amount stated. The period of repayment would be such as to make the project self-supporting.

Bolton.—The Tramways Committee have decided to increase tram fares from April 4. It is the last tramway authority in the country to take this step. The Borough Treasurer estimates that for the next financial year the department will require an additional income of £30,000 to ensure that it shall not be a charge on the rates. After six months' working of the new fares the financial position will be reviewed.

Lunesdale.—The Rural D.C. have appointed a committee to report respecting the new electricity supply scheme. Mr. Marshall said the cost would be enormous. If it reached £1,000,000, they would have to pay £40,000 in Lunesdale, or equal to a rate of 1s. 8d. in the £. He suggested they should apply for exclusion. Mr. Beckett said they had rivers in the district and they were not using the cheap power which was available.

Nelson.—The T.C. have accepted the tender of the Anglo-Belgian Improvement Corporation for points and crossings with fish-plates, and bolts complete. Ald. Cooke said the Committee were staggered when they received the Belgian firm's tender, which included delivery at the Tram-shed, and Lloyd's Certificate of quality was given as a guarantee. The firm also offered to pay the expenses of the local engineer to inspect certain rails which the Corporation required. At a conference of tramway managers recently, it was stated that Continental rails lasted longer than English rails. The prices of English firms tendering were £1,740, £1,719 and £1,680, whilst the accepted tender was £840.

Service Notes.—It is understood that in the coming June, July and August, exhaustive experiments will be made as to the possibilities of wireless control of certain sea-going craft, experiments which have been more or less successfully carried out in the U.S. Navy. The old battleship "Agamemnon" will be fitted up as a target ship, equipped with a powerful wireless installation, by which she will be manœuvred whilst guns and torpedos in turn work their will on her. Of course, the target ship will not be manned. Seven mechanist electricians with a knowledge of wireless telegraphy are required for the Indian service—a two years' engagement, 350 rupees per month, free quarters or allowance in lieu, free medical attendance and free passage outwards.

"Installation News."—The February issue of this bright little quarterly publication, published by Simplex Conduits, Ltd., as usual contains much interesting information. First we note that over 33⅓ per cent. of the Company's male staff and workers are ex-Service men, and well over the 5 per cent. required for inclusion in the King's Roll of Disabled Men are employed; then after the opening editorial comes an article on Technical Literature, by Sidney Rentell (Editor of Electricity). A new series of 5 amp, rectangular multiple switch-boxes is illustrated and described, features being the ease of wiring, and general simplicity, neatness and reliability. Then follows a plea for more humour in technical publications and business generally, and some useful hints on Simplex conduit installations in houses, while to finish up with we have some notes on salesmanship.

Port Improvements at Newcastle, N.S.W.—In the course of a paper on this subject, before the Inst. of Civil Engineers, Mr. Percy Allan, M.Inst.C.E., gave some details of the electrical equipment. Newcastle, on the Hunter River, is the principal coal port of Australia, with a record export of 5,236,621 tons for 1913. In the year 1910, there existed 9,500 feet of Government coal wharfage. This, however, was considered insufficient, and the construction of a coal-loading longshore wharf was decided upon. The wharf—1,725 feet long by 41 feet 5 inches in width—is of timber, and carries six 15-ton high-speed electric travelling cranes, each weighing 209 tons, and costing £47,700 complete. The main features in the design of the cranes are the method of distributing the loading on the live ring of rollers, the high speeds and the low unit-stresses adopted. The machinery for hoisting, sluing and travelling is actuated by separate D.C. series-wound motors, driven by current taken from a third rail running the whole length of the wharf. The current is supplied from the Tramway Power House about two miles away to a sub-station at Carrington, and thence to the third rail. The cranes were constructed by Messrs. Cowans, Sheldon & Co., of Carlisle, and upon erection *in situ* were subjected to a series of tests with a 51-ton load, the following being the results obtained: Hoisting—118 ft. per min.; Sluing—366 ft. per min. at 55 ft. radius; Traversing (with a flying start of 10 secs.)—an average of 139 ft. per min. over 100 ft. The contract price for the six cranes, complete and including conductor rail, was £48,197, ship's slings, Newcastle.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
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MARCH 18, 1921.

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THE AMRITSAR HYDRO-ELECTRIC IRRIGATION INSTALLATION.*

By Stephen Leggett, M.Inst.C.E.

The subsoil water-level at Amritsar, in the Punjab, which was 60 ft. below the ground in 1860, had risen in the course of nearly 40 years to 10 ft. below the surface. During the rainy season, which occurs in the hot months, mosquitos breed in the stagnant water, and consequently the city becomes infested with the germs of disease. It was recognised that the rise in the subsoil water-level was due to the proximity of the Upper Bari Doab Canal, which runs at a distance of three miles from the city, but no method of water-proofing the bed of the canal has so far proved effective.

In 1908, experiments were carried out to test the possibility of pumping from open wells and cuts, the water to be used for irrigation purposes; they were abandoned, as a 10 ft. diameter well yielded only 0.1 cu. ft. of water per sec., and open cuts became clogged with vegetation. In 1911, at the suggestion of Mr. John Ashford, a special tube-well 4 in. in dia. and 40 ft. deep, was sunk. This yielded $\frac{1}{8}$ cu. ft. per sec. at an expenditure of 6 h.p. per cu. ft. of water lifted. These wells gave satisfactory results over a period of two years, and were considered to afford a solution of the problem.

A power-station was built on the canal at a point where there is a fall of 5.8 ft., to utilise one-half of the flow of 2,100 cu. ft. of water per sec. The station contains three low-pressure turbines coupled to alternators through gearing, and has an output of 525 k.w., three-phase, at 6,600 volts. Two H.T. lines, seven miles and two miles in length respectively, are led to sub-stations for transforming to 550 volts. A special sub-station is provided for transforming 75 k.w. A.C. to D.C. for the Central Workshops of the Punjab Canal System. Each sub-station feeds six pumps, the designed capacity of the power-station being forty pumps, together with the workshops; this can only be obtained when the fall is increased to 9.7 ft.

The author describes the method of sinking the tube-wells, which are about 160 ft. deep and have 120 ft. of 10-in. wire-wound strainer. The pump is located in a brick sump 22 ft. deep, and is thus self-priming, being below the normal subsoil water-level. It was known that the discharge of this type of well is proportional to the infiltration head maintained, and it was decided that a flow of less than 2 cu. ft. per sec. was not economical for irrigation purposes. Most of the wells gave this discharge under an infiltration head of 14 ft., but in some cases 21 ft. head was required, this being due to the presence of beds of clay in the sand. The pumps are direct-coupled to 15 h.p. 500-volt electric motors running at 970 r.p.m. Owing to difficulty in obtaining suitable pumps from British makers, the author designed a single-stage turbine pump, which was made in the Central Canal workshops. The normal lift was estimated at 40 ft. These pumps are satisfactory, as they do not overload the motors at starting and have an efficiency of 70 to 73 per cent. for all heads between 30 and 45 ft.

An improved well was also designed by the author, from which the brick sump was eliminated. In this type the pump is carried in a 14 in. tube, necessitating a two-stage turbine pump design to give the required output. At 40 ft. head, with a discharge of 2 cu. ft. per sec., this has an efficiency of 75 per cent., including the friction of the driving shaft and suspensory thrust-bearing. The average power per cu. ft. does not exceed 5.5 h.p. Ball-bearings were used for the thrust-bearings on the vertical pump-spindles, but were found to be unsuited to the climate, and have been replaced in all cases by Mitchell thrust-bearings running in oil baths. These give every satisfaction. At present a total of 30 cu. ft. per sec. is pumped, and although no definite effect on the subsoil water-level has been observed, it is expected that there will be a diminution of water-logging when the proposed 80 cu. ft. per sec. is abstracted.

Each of the three turbines requires 350 cu. ft. per sec. on a 9 ft. fall to produce 750 k.w. at the generator. They run at 92 r.p.m., and drive the generators through double-helical gearing, the latter running at 500 r.p.m. The power-station foundations are on sand, and consist of wells of bricks, 8 ft. square in section, sunk at close spacing.

The transmission lines are carried on steel lattice towers, strong enough to stand unsupported should all the wires on one side break suddenly. They are set in concrete blocks and are spaced 300 ft. apart in open country. The sub-stations contain three single-phase oil-cooled 6600/500-volt transformers, and the pumps are started from the sub-station switchboard.

The work was done by native labour, but a European overseer supervised the erection of the machinery. The total cost was £33,000, and the revenue derived is £2,400 per annum. This is insufficient to leave any profit, but it is anticipated that the return will be about 5 per cent. when the scheme is extended to the limit of its capacity.

The author also deals with the need for some type of self-cleaning strainer-rack for such work, and for more effective ventilation of the power-station.

The turbines and electrical machinery were constructed by Gilbert Gilkes, Ltd., of Kendal, and The Lancashire Dynamo and Motor Co., Ltd., respectively.

* Abstract of Paper read before the Inst. of Civil Engineers.

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HOW TO ATTAIN SUCCESS IN THE ELECTRICAL INDUSTRY OF TO-DAY.

Mr. Ll. B. Atkinson (President I.E.E.) recently gave an address to the Students' Section. After laying stress on the value of Students' Sections—there are now 400 members of the London Students' Section—Mr. Atkinson discussed the possibilities open to young electrical engineers. It was generally recognised, he said, that, for a given level of ability, material success would be greater on the commercial rather than the scientific side.

A young engineer should study the principles of business organisation, and finance and economics, as well as the purely technical side of his subject. He should also study the markets and prices of the raw materials used in his industry, changes in methods of production, new sources of raw materials and new demands on allied industries, etc. He should be familiar with the elementary principles of contract law, the transfer and rights of property, etc. Again, the legal obligations of employers and employed should be investigated, as well as the principles of capitalisation and the control of limited companies. Above all, let the young engineer be determined to resist the little lazy habits of thought and expression which are likely to be developed unless carefully watched, and make an acquaintance with men in the profession who were usually only too willing to help the young engineer in every possible way. Mr. Atkinson acknowledged the help and guidance given to himself by the late Sir William Siemens, Sir William Preece, Professor W. E. Ayrton, Professor S. P. Thompson, and others. He urged young engineers to realise the importance of personal character and regularity of life and work, unfailing good temper at all times of difficulty, and the power of a smile. Finally, all engineers must adapt themselves to the changing conditions about them.

We were always (continued Mr. Atkinson) in the face of conditions which we could not alter, and it was wisdom to adapt ourselves to them. To-day we were going through a change in conditions which might make a difference to young engineers in the diminution of wealth, temporarily, at any rate, but this need not necessarily mean a diminution of contentment. If education, refinement, and regard for others were equally distributed, much that we disliked in the present changes going on would disappear. On the whole, engineers had a wider and more tolerant outlook on these matters than other professional classes, because in youth they were in immediate working contact with manual workers as part of their training.

Touching on the formation of the Scientific Workers' Union, Mr. Atkinson said that a manifesto had recently been issued by that body complaining of the exploitation of scientific research workers by commercial firms. In plain words, what he thought it was intended to convey was that a scientific discovery made by a person definitely employed to carry out research—in order to make discoveries—was in a different category to a design produced by a designer paid to design. That, to his mind, was entirely fallacious. Researches which did not lend themselves to private ownership should be undertaken by the State. The final answer to any such argument would be for research workers to combine and get someone to sell their results; but the fact that they had not been able to do so rather indicated that the selling of discoveries was more difficult than the making of them.

A designing engineer (continued Mr. Atkinson, on the general question of training), when he came to design a machine, must clearly apprehend the purpose of the machine, the space available, the weight allowable, the speed at which it must work, and the price it is worth to the buyer. He must decide on the conflicting claims of these different elements, and be able to make up his mind as to the degree to which he will finally admit these claims. Having done so, he must design a machine, and finally be able to convince others that the design is a correct one and superior to any other. If he were a commercial engineer, he would have to deal with some of these problems at a later stage. Comparing the difference in material reward as between a designing engineer and a commercial engineer, he said the designing engineer only indirectly felt the benefit or loss arising from the correct and incorrect solution of the problem he had set out to solve. He would feel it by his employer retaining, or other employers wishing to secure, his services, and that would reflect on his salary. On the other hand, the commercial engineer immediately realised the result of the design on the profit or loss arising and the money value of his services, and this would more quickly reflect itself on his earning power. Perhaps it was because of that that the best paid jobs were on the commercial rather than on the engineering side.

Summing up a thoroughly interesting address, Mr. Atkinson said he had seen many failures by young men to achieve success because they had not understood the necessity of some of the things he had pointed out. Indeed, if he himself had been told, and absorbed to the point of understanding many of the points he had mentioned, some of his own troubles would have been saved him.

THE OSRAM DINNER.

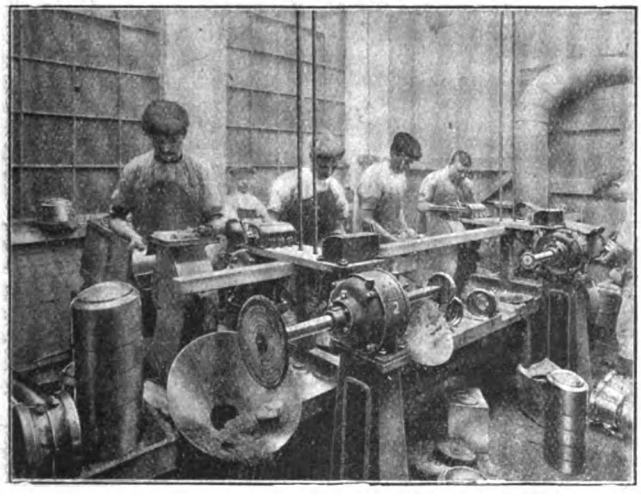
On Friday, the 11th inst., at the Café Royal, Mr. Chris. Wilson presided at the annual staff dinner of the Osram-G.E.C. Lamp Works. He was supported by about 130 of the employees and visitors, including directors of the company and the secretary, Mr. L. C. Gamage. There was a splendid musical programme, and the toast list was commendably brief, although the speeches were able and to the point. After "The King," Mr. W. F. Franks proposed "The Firm" and referred to the fact that so far as the lamp works were concerned they were mainly dominated by the word "efficiency." In other words, he said, that "efficiency spells electricity" and conversely "electricity spells efficiency." He coupled with the toast the name of Mr. S. D. White, a director, whose reply was frankly pessimistic. He referred to the difficult position of trade in this country as a whole and said that in the absence or reduction of our export trade we were practically living on ourselves, and that labour must wake up rapidly to the bedrock fact that a big increase in work and output does not mean lower wages. Mr. Wilson also responded, but he was more of an optimist. He admitted that the difficulties to be overcome are now far more severe than at any previous time. On the other hand, they were now in a better position to meet competition than at any time

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in their history and much of this was due to the facilities which had been afforded to him and Mr. Driver to go and see what other people were doing. By comparison he found they were not so badly off as they thought they were. This was due to combined labours of the management and the staff. The research department provided by the G.E.C. had proved of immense benefit and was likely to be even more so in the future. Undoubtedly efficiency must be their watchword in business, and he had every confidence it would be so. He spoke in terms of high appreciation of the staff at Brook Green, and alluding to their vitality and enterprise he said that with their assistance the G.E.C. would come out on top as it had done for so many years past. The speech was received with much applause. Later, Mr. J. F. Jessop proposed "The Chairman," and said it was seldom a works' organisation had a chairman who was so well known as this one, who was in every sense of the word a remarkably good business man, in that he was a good general manager of the lamp works, a good sportsman and also looked after the welfare of the staff. He referred to the growth of the works under Mr. Wilson's control and also to the trouble which he had taken to find a really good sports ground for the employees of the company. One thing they could all say, Mr. Wilson kept his position to the entire satisfaction of the staff. In fact the staff were thoroughly satisfied with him. (Laughter). Mr. Wilson responded in a few well chosen words and also brought in a happy reference to his 26 years' working association with Mr. Driver, who was one of the hardest workers of all of them. The concert was then continued to a late hour, and a very happy evening was terminated with the national anthem.

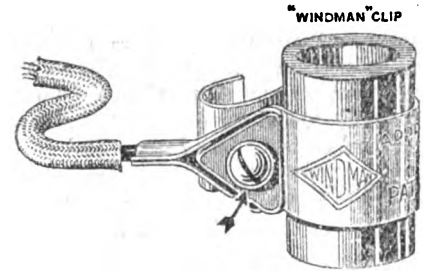
BUFFING MOTORS.

Buffing being a process effected at high speed, it can at once be appreciated that an individual electric drive is the correct one to adopt, but, owing to quantity of grit and dirt invariably present in a polishing shop, and to the overloads on the motor, and great stress put on the bearings due to the operators pressing the work on to the mop with their full weight, the motor must be specially designed for the work. Standard motors with elongated shafts are quite unsuitable, so that it is of great importance to obtain them only from a firm of manufacturers who have given the problem special study—for example, the Metropolitan-Vickers Company, Ltd. (Trafford Park, Manchester), who have supplied large numbers with most satisfactory results, one installation being illustrated. The motors are made from ¼ h.p. to 2½ h.p. for D.C. and 2 and 3-phase circuits, and have specially designed bearings, large diameter shafts, massive end brackets, and special dust-caps at the nose of the bearings to prevent grit entering along the shaft.



THE "WINDMAN" EARTHING CLIP.

A new earthing clip, known as the "Windman," is being put on the British market by Mr. Maxwell Goldsmith, 4, Florence Terrace, Ealing, W. The illustration shows the clip in position. It consists of a strip of tinned copper with one end bent into position for the reception of the earthing wire, a hole where the straight part of the strip begins with a copper bolt through it and a series of holes towards the other end for use on various sizes of pipes, conduits, tubes, etc. In use the strip, which naturally is very flexible, is bent round the pipe in use with the bolt through the hole at the earthing wire end and the hole at the other suited to the size of the pipe, and a copper nut tightened up, the nut being locked by the springiness of the bent strip. A lock nut can be added if thought desirable. Another feature is the triangular copper washer under the slotted bolt-head where the earthing wire is attached—by this construction the washer cannot rotate.



The strip is made in three lengths and two gauges, one for house service and small installations and one heavier for use where large earth currents may be anticipated. The strips are provided for pipes ⅜ in. to 1 in., ⅜ in. to 2 in., and ⅜ in. to 3 in. dia. Being flat, a minimum of space is required for storage or carriage. It will be appreciated that there is an advantage also in one clip being adaptable to different sized pipes, while the materials used ensure an efficient connection, provided, of course, that the pipe is properly cleaned. By the way, the other day we ran across a design of earthing clip in which all the parts were carefully enamelled!

AN INTERESTING LECTURE AT CARDIFF.

Mr. W. T. Kerr, Chief Electrical Engineer for the rural supply of the County of Hereford, gave a very interesting and instructive lecture to the members of the South Wales Inst. of Engineers on "The Prospects of Electricity in Agricultural Centres." Mr. Kerr said that, to be of any use to those engaged in agriculture, there must be a cheap and abundant supply of electrical energy available, for although a certain amount might be done by small isolated generating plants, they were costly to operate and required a considerable amount of attention. In agricultural areas there was a great field for exploitation by the electrical industry, and never more so than at present, for there was a market for every one of the products of the electrical manufacturer. He demonstrated the enormous saving in money now sent abroad that would follow the introduction of a universal electrical supply, and also described the type of transmission line best suited for rural work. In Herefordshire

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the supply was generated at 3,000 volts 50 cycles and distributed at that pressure up to a six-mile radius. From there, for longer distances up to 30 miles, the pressure was to be raised to 11,000 volts, whilst the main lines were erected for an alternating working pressure of 11,000 volts. The lecturer also gave the results of experiments which had been conducted in various parts of Hereford County.

SHOP MANAGEMENT.

At a meeting of the Birmingham and District Electric Club, on Saturday, March 12th, a paper was read by Mr. H. C. Young, A.M.I.E.E., member, upon "Common Sense Methods of Recording Costing and Progress in Shop Management."

The paper was an interesting and valuable contribution to a most important subject. Mr. Young gave much valuable information from his own experiences in the management of large works. He insisted upon the importance of rapidly understood graphic records of day by day, and in some cases, hour by hour progress. He had found that it was quite simple to devise a datum line, showing a ratio between input and outgoings for the main details of factory cost, whether labour or staple materials. To fall below this line spelt danger. These records should be simple and easy to understand, kept regularly posted and displayed where everyone interested would see them; so that at a glance, all could see the immediate tendencies and as soon as the actual line fell below the datum line steps could be at once taken to investigate causes. These records were live information, and not as is often the case merely evidence of an inquest upon a dead affair; available only too late to be of use.

THE COMPOSITION OF LIQUID AND GASEOUS FUELS.

Kerosene is one of the products obtained from the distillation of petroleum, and comes over after the more volatile motor-spirit has been obtained. It is heavier than the latter, having a specific gravity varying from .78 to .83 depending on its composition. It has a flash-point beyond 72° F., the temperature at which it gives off enough vapour to cause it to ignite when a low temperature flame is held over its surface.

Motor-spirit is lighter, bulk for bulk, than kerosene, weighing from 42.5 to 45 lb. per cubic foot, the latter weighs from 49 to 52 lb. for the same volume It gives off vapour at a lower temperature, and therefore has a lower flash-point than kerosene.

Both of these substances have a very high calorific value, the best brands of motor spirit a calculated value of 20,700 and kerosene 20,200 British Thermal Units per pound, but bearing in mind that the latter is heavier, and taking equal volumes of each, say a gallon, the kerosene has a higher heating value. As tested by the calorimeter, the values are 19,760 and 19,000 B.T.U.s per pound.

Commercial or power alchohol is the ordinary spirits of wine, admixed with a proportion of wood spirit, or methyl alcohol, thus rendering it unfit for human consumption. The term "absolute," as applied to alcohol, is the chemically pure material, and is hardly known outside the chemical laboratory, whereas ordinary spirits has about 10 per cent. of water present. The calorific value of power alcohol is about 10,800 B.T.Us. per pound—little more than half that of motor-spirit, still, it is a good working substance when petrol is used to start the operation in the engine, running on the former when the engine has become warm. One pound of alcohol is allowed to produce nearly 2,000,000 foot-pounds of work.

Gaseous Fuels. The combustible gases of these fuels are hydrogen, the hydrocarbons methane and ethylene, and the lower oxide of carbon, with nitrogen, carbon dioxide, and oxygen as diluents, and their calorific values are determined by the fact that the four first-named burn to water and carbon dioxide on complete combustion. A cubic foot of Ohio natural gas has a heating value of over 900 B.T.Us., while the same volume of blast-furnace gas only reaches 100 B.T.Us. In the first the diluent nitrogen is present to the extent of 3.8 per cent., in the latter 57 per cent., and this in large measure accounts for its low heating value.

Carburetted water-gas is rich in methane and carbon monoxide, nearly .30 per cent. of each, with 22 per cent. hydrogen and 13 per cent. ethylene, leaving only a small proportion of diluents. Its heating value works out to 660 B.T.Us. per cubic foot.

Uncarburetted water-gas should theoretically contain equal volumes of hydrogen and carbon monoxide. An analysis of a sample yielded the following composition:—

Hydrogen	50
Carbon monoxide	36.5
Methane	1
Non-combustible	
Nitrogen	8.3
Oxygen and carbon dioxide	4.2

and gave a heating value of 280 B.T.Us. per cubic foot.

Coal-gas made from Yorkshire coal is very rich in hydrogen and methane, with small amounts of carbon monoxide and ethylene. The diluent, nitrogen, is about 1-12th of the volume, thus reducing both its illuminating and heating values. The latter is about 612 B.T.Us. per cubic foot. Its analysis is:—

Hydrogen	39
Methane	42
Carbon monoxide	8.3
Ethylene	2.7
Diluents	8

Other fuels are Mond and Dowson gas, producer gas and blast-furnace gas, and are the poor members of the family of gaseous fuels. Their only merit lies in their cheapness, as the heating values only range from 150 to 100 B.T.Us. per cubic foot. Generally speaking, they contain over half their bulk of nitrogen, and are rich in carbon monoxide, blast furnace gases are a case in point. Mond, Dowson and Siemens producer gases contain a large proportion of the combustible gas hydrogen, but so much nitrogen reduces their calorific values greatly as compared with natural gas, water-gas and town gas.

A NEW SCOTCH HYDRO-ELECTRIC SCHEME.

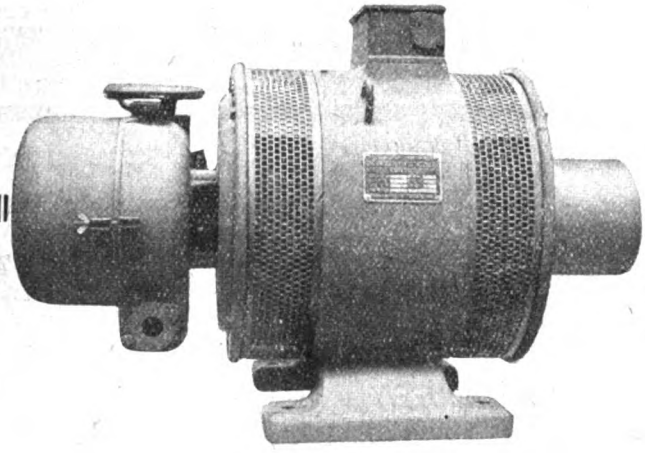
According to the *Times* a petition has been presented to the Secretary of State for Scotland for the grant of a provisional Order incorporating a company for the purpose of constructing works for generating electricity by water-power in the neighbourhood of the Grampian Hills. The petition is signed by Sir H. Babington Smith, Sir A. E. Harris, Sir Guy Granet, and Mr. J. F. Cox.

It is proposed to incorporate the company under the name of the Grampian Electricity Supply Company, with a capital of £1,000,000, which may be increased to £4,000,000 with the sanction of the B.O.T. It is also proposed that the company should have the right to issue Debenture stock for any sum not exceeding "the whole of the amount of capital which at the time of borrowing has been issued."

The scheme includes the construction of 48 works to use the water of locks and rivers by collecting it in 10 reservoirs, to be formed principally by dams across rivers and locks. The generating stations are proposed to be erected at Fortingall and Blair Atholl, in Perthshire, and Luggan and Kingussie and Insh, in the county of Inverness. The area of supply is to comprise the whole of the counties of Perth, Kinross, and Forfar, and certain areas in the counties of Inverness, Argyle, Stirling, and Dumbarton.

The price proposed to be charged to large consumers is not to exceed 3d. per unit, and to ordinary consumers the maximum is not to exceed 8d. per unit.

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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

A Curious Breakdown.

The failure last December of one of the new 15,000 k.w. turbo-alternators at the Dalmarnock power station, Glasgow, after the set had been in commercial service only two and a half months, has since been traced to a curious source which is commonly overlooked in the design of most machinery, and has a special significance where alternating currents are concerned. It was reported at the time that the insulation on the windings at one end of the machine took fire, and, as some delay ensued before the turbine could be brought to rest, the whole of the insulation at that end of the machine was destroyed. It need hardly be added that the manufacturers, the Metropolitan-Vickers Company, had taken every precaution to ensure perfect workmanship before the set was placed in service.

Curiously enough, a second and similar set, which was substituted for the original, had to be shut down after about a week's service, as sparks were noticed issuing from the top of the stator frame. So strange a coincidence prompted careful investigation of the trouble, which was ultimately traced to a breakdown in one of the insulated bolts through the core near the end plate. Examination of the bolt itself showed its failure to be due to excessive vibration, which, however, was at first sight discounted by the fact that other exactly similar bolts had not failed. A careful and systematic series of tests, however, disclosed the fact that, for the particular size and length of bolt employed for the cores, a relatively slight tension on the bolt sufficed to adjust their natural frequency to the natural vibration frequency of the whole set, corresponding to the normal speed of 1,500 r.p.m.

In other words, a condition of resonance had been set up, and the bolt had ultimately given way through the process known as crystallisation. The same cause proved to have led to the original breakdown, and when all these bolts had been replaced by copper ones of smaller diameter, having a totally different natural period of vibration, no further trouble was experienced. The incident is extremely interesting, and opens up a new study for designers of electrical machinery. It is a well-known fact that glasses and ornaments in a room are automatically set in vibration when certain notes are struck on a near-by piano which correspond with their natural frequency. Glasses have even been known to fracture due to the same cause, and one can well visualise the rapid disintegration of bolts under natural tension, subject to the constant vibratory influence of a large alternator.

Irregular Shillings.

Nothing has been quite the same since the great war. Our manufacturing quality and accuracy has shown a falling off in many directions. Even the nimble "bob," as turned out in hundreds of thousands by the Royal Mint, is apparently subject to variation if report speaks truly. In many flats it is now the custom to install pre-payment electricity meters operated by this ubiquitous coin, and the collectors state that the considerable increase in breakdowns of these meters is traceable to the irregularity in the thickness of the new coinage, a fact quite unknown by the community at large.

Labour's Share.

Some interesting figures published in connection with the London Electric Supply Corporation are informative at the present time when Capital is alleged to be getting more than its fair share of the fruits of industry. Out of every pound sterling paid by the consumer for electrical energy during 1920, 12s. 8d. was expended on Labour, including salaries and raw materials, the latter presumably covering fuel, the cost of which would also be largely represented by the wages of the colliers. Rates and taxes accounted for another 2s. 10½d.; depreciation, reserves and interest on debt, 3s. 0½d.; leaving 1s. for Preference dividend, and 4d. for Ordinary dividend. Under such circumstances those who risked their money to provide Londoners with electricity could scarcely be accused of profiteering.

Checking the Tram Habit.

According to the traffic returns, it would appear that Liverpool has at last found a sure remedy for the tramway overcrowding which has prevailed in the city for some years past, and has brought the system into such disrepute. Since the introduction of a minimum twopenny fare and the raising of the other rates for certain stages, the number of passengers carried in ten days decreased by 870,000, as compared with a corresponding period of last year. At the same time the receipts increased by £5,174, and it was stated that the legitimate long-distance passengers had not been so discommoded since the new fares had been in operation.

There is no doubt that the cheapness of the penny ride, now a thing of the past, has created a tendency to jump on the cars for any short-distance trip rather than walk, a far healthier means of locomotion, given fine weather. As to the time saved by using the cars, there is not much in it where short distances are concerned, especially if the frequent stops in busy city streets are taken into account. The moral aspect of the policy is another story; and, whether there is any justification for fleecing the public as a remedy for overcrowding, I leave it to the public to judge—suffice it that a private trading concern meets an increasing demand by increased facilities, a natural and progressive policy which, however, does not seem to appeal to our traffic mandarins of the municipalities.

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Lifting Magnets.

Few readers appreciate the extent to which electric magnets have been developed, and are in use, for handling magnetic materials, whether in scrap or other form. A paper read by Major F. A. Hooper, at a recent meeting of the Staffordshire Iron and Steel Institute, on the subject of "Electric Lifting Magnets," is therefore of more than passing interest. The lifting magnet enables cranes to be operated continually at their maximum speeds, as many as 60 to 70 trips per hour being accomplished in many cases by this means. First introduced in America some twenty years ago, the lifting magnet soon found favour in Germany, whilst certain enterprising British steelworks engineers experimented with magnets of their own design. Eventually an enterprising electrical engineer made a special study of the subject, and took up the manufacture of such magnets on a commercial scale.

Three principal types have been evolved—viz., the circular magnet for handling loose metal; the rectangular magnet for handling sheets and plates; and the bi-polar magnet for manipulating sections and billets. In Germany a number of lifting magnets were being wound with insulated aluminium strip, relying on the natural oxidation for the electrical isolation of the contiguous turns. Actual performances showed that when dealing with solid loads a magnet would lift from five to fifteen times its own weight. When, however, light scrap had to be handled, the capacities came down owing to the lighter weight of the load per cubic foot and the smaller surface contact with the load. A magnet crane of average capacity costs from £3,000 to £4,000, and with present wages a capital expenditure of £1,000 was justified to replace one man, making due allowance for depreciation, capital charges, etc., on a ten-years' purchase basis. Instances of lifting magnets replacing ten men were on record, and the greatest savings were effected when handling loose materials such as scrap turnings, pig iron, crop ends, and the like.

ELEKTRON.

SYDNEY TRAFFIC IMPROVEMENTS.

The Sydney Press has been giving considerable prominence to various traffic improvements tentatively approved in 1913 and understood to be once more under consideration by the N.S.W. Government. The improvements mainly concerned are :—(1) Construction of Sydney electric bridge; (2) Construction of Sydney electric railway; (3) Electrification of certain suburban railways.

It is said that the Sydney harbour bridge which will connect the city with the northern suburbs is to be of the cantilever type, spanning the harbour in one clear span of 1,600 ft. and accommodating railway, street cars, vehicular, automobile, and pedestrian traffic. It has been estimated by the Chief Engineer for metropolitan railway construction (Mr. J. J. C. Bradfield, M.E., M.Inst.C.E.) that the bridge will cost approximately £5,000,000.

The present street tramway and suburban railway systems have now reached a point where further expansion of the service to meet the increasing demand for travelling facilities is impossible. The authorities have come to the conclusion that the only solution of the problem is a loop system of electric railways running into and around the city. The proposed railway will be carried partly on viaducts, partly on the street level, and the remainder underground. Where underground, practically the whole construction is through Hawkesbury Sandstone, a hard sandstone formation lying in nearly horizontal beds, traversed by occasional thin bands of shale and overlaid by shale and clay. Construction will be carried out by open cut and tunnel. Both brick and concrete will be used for lining, and steel frame construction where the head room is insufficient for tunnel section.

A certain amount of the work in connection with the railway was commenced in 1916 and proceeded until June, 1918, when, owing to war conditions and the difficulties of obtaining plant and material, the Government thought it desirable temporarily to suspend operations. The estimated cost of the railway is approximately £3,750,000.

The Chief Engineer anticipates that tenders will be advertised about October of this year, and is said to be of opinion that twelve months should be allowed to contracting firms for the preparation of their tenders, which would thus be returnable about October, 1922.

Firms interested in this proposed contract are reminded that Australian Government departments lay down, as a general rule, that overseas firms desirous of tendering must have a representative resident in the Commonwealth, otherwise their tender will not be considered. The services of the B.O.T. Department of Overseas Trade and its representatives abroad are available to firms wishing to appoint agents in Australia or in any overseas country.

SUPPLY OF ELECTRICAL POWER TO INDUSTRIAL WORKS,

WITH SPECIAL REFERENCE TO THE DESIGN OF SUB-STATIONS.*

BY A. P. ROBERTSON, A.M.I.E.E.

(*Continued from page* 150.)

There are various arrangements for these sub-stations and each one has to be designed according to the room available and its situation with regard to distribution of the power. Whenever possible the building should be high enough to lift the coils out of the transformer and without removing the transformer tank from its position. This is accomplished by having a beam fixed close to the roof immediately over the centre line of the transformer. A trolley runs along this beam carrying a block capable of lifting the core. The core can be lifted clear of the tank and travelled along and then lowered to the floor, so that any repairs or inspection can be effected without removing the cabling.

When the cabling is heavy lead covered material this will be appreciated.

It should be borne in mind that a sub-station should be designed to facilitate quick replacements of heavy machinery, so that in the event of a breakdown the faulty apparatus can be taken out quickly and a new part put in place. In many cases the whole works depend for their power on the sub-station and it is imperative that the faulty apparatus should be repaired and replaced as quickly as possible.

The height required to meet the above conditions is considerable, and the building is high enough to divide part

*Paper read to the Royal Technical College Scientific Society, Glasgow, December 4, 1920.—Reprinted from *The Channel*, January, 1921.

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of it into two floors. The high tension switchboard is housed on the ground floor level and the L.T.A.C. switchboard is housed on the upper floor.

The E.H.T. switchboard has similar characteristics to that already described, but the L.T.A.C. switchboard differs both from this and the D.C. switchboard.

The L.T. switchboard is a three-phase 440 volt job and is stayed 6 ft. 6 in. from the wall. The panels are heavy slate enamelled back and front, and have the switches mounted on the framework.

The busbars are on the top, and must be fixed firmly to the insulators on the stays.

All the current from the transformer is taken through the main switch on the transformer control panel and passes along the busbars to the feeder control switches. Current transformers are inserted in the line of the busbars immediately on the feeder side of the main switch, and therefore all the current is measured whether one or more transformers are working.

The metering is by three single-phase and a polyphase maximum demand meter, so that any out of balance due to lighting or single-phase motors can be taken care of. The neutral point is taken from the transformer to a fuse connected to earth, and all the neutrals for the feeder circuits are controlled by links on the transformer side of this fuse. The fuse is shunted by a bank of lamps, so that in the event of an earth developing on any phase the earth fuse will blow and a circuit will be provided to earth through a high resistance. The lighting of the lamps will draw attention to the fault.

All the small wiring is made standard, no matter what make of switchboard is installed, and the wiring is coloured so that it can be easily traced standing at the back of the board and without touching it. This is a great convenience in tracing the connections.

All the main cabling is also run to standard connection and colours so that two transformers can be connected to the switchboard and phased without any temporary connections for trial.

The switches are of the oil break type and are generally fitted with spring action so as to open quickly on a fault. The feeder circuits are protected by overload and no volt release.

When only one transformer is installed the protection is on the H.T. side and consists of overload and leakage as shown in diagram Fig. 3.

The H.T. switchboard has three current transformers and the two outers are connected for overload while the centre one is connected for leakage. A separate relay may be installed for leakage or the centre element of a three-pole relay used.

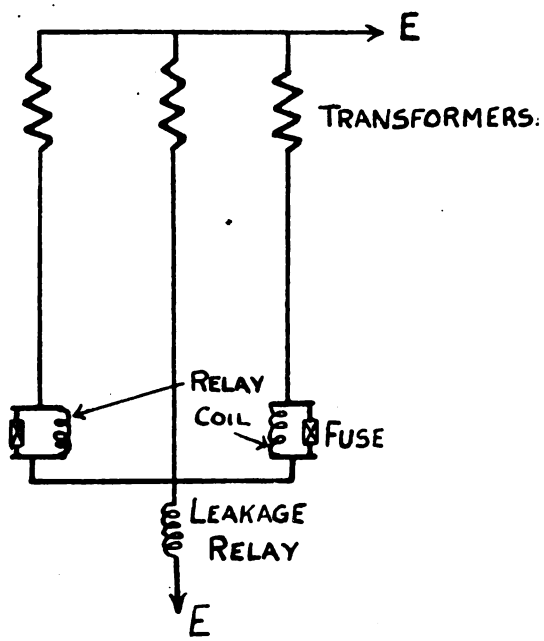


FIG. 3.

When, however, two transformers are working together protection on one side of the transformers only is not sufficient. Suppose a fault develops in the H.T. winding of one transformer, the H.T. switch for that one comes out but the L.T. switch stays in and current is fed back from the other transformer to aggravate the fault. The trips are therefore connected to both H.T. and L.T. switches, so that both trip at once. But this does not prevent the switches staying in if a fault develops on the L.T. winding until a very dangerous current is set up. The overload on both transformers then comes into play and both are disconnected. This means an interruption of supply, and to get over this and ensure that only the faulty transformer is cut out while the other is kept on the busbars, circulating current protection is employed.

The connections are shown in Fig. 4. Three current transformers are required on the L.T. side of the main power transformer.

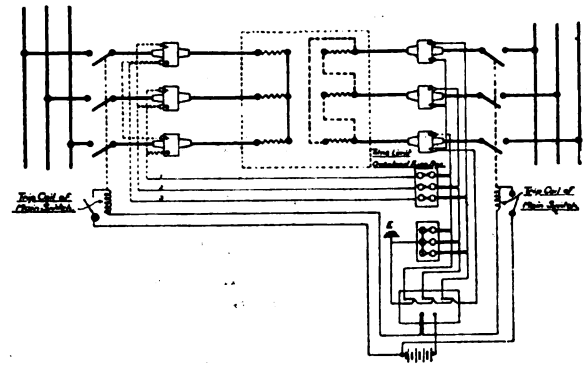


FIG. 4.—DIAGRAM OF CONNECTIONS FOR TRANSFORMER PROTECTION OPERATING THROUGH TRIP COIL OF MAIN SWITCH.

The diagram shows the protection for a delta star transformer. For a star star transformer the protective transformers are star star. There are three current transformers on each side of the power transformer connected as shown. The H.T. transformers are connected in star and the L.T. in delta, and three wires are run between them. A tapping is taken off and is connected to an overload relay, also connected in star, and each coil is shunted by light fuses to give a time limit to the overload.

Series fuses are inserted in the three-main connecting leads. As long as the currents are equal in the H.T. and L.T. sides of the main transformer, the balance is maintained in the protective system, but on a fault the fuses blow and the current flows through the relay fuses, which blow also. The current then flows through the relay coils, which act and close the tripping circuit, thus opening both switches.

It will be noticed that no metering is performed on the H.T. side of the system. Meters require potential transformers on high voltages, and these are a source of danger. If the metering is on the 440 volt side, no transformers are required, and only fuses need be fitted. All potential wires are fitted with fuses as near the live points as possible, and the fuses, wherever possible, should be fitted in front of the panels and insulated.

(To be continued.)

Marley (Yorks).—At a meeting of the local council, Councillor H. Rhodes, in moving the minutes of the Electricity Committee, said that all arrangements for taking a bulk supply from Leeds were nearing completion and they proposed to start on April 1 next. Most of the members of the present staff had been given notice of termination of employment. The men, however, would be entitled to put in a claim for compensation under the Act. The plant and surplus boilers would be advertised for sale.

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TELEGRAPHY.

FINAL EXAMINATION, 1920.

Q. 1.—State the law for the establishment of a current in a circuit possessing self-induction.

A 900-ohm sounder having an inductance of 20 henrys is worked in the local circuit of a relay from a 24-volt battery. Find the value of the current passing in the sounder after an interval of 1-45th of a second from the time of closing the circuit.

A. 1.—The law for the establishment of a current in a circuit possessing self-induction is known as Helmholtz's Equation and is represented symbolically, thus :—

$$C = \frac{E}{R}\left(1 - e^{-\frac{Rt}{L}}\right) \ldots\ldots\ldots\ldots (1)$$

where E volts is the e.m.f. acting in a circuit of resistance, R ohms and inductance, L henrys, $e = 2{\cdot}7182$, the base of the Napierian logarithms, and C amperes the current flowing in the circuit t seconds after the circuit has been closed.

In the example given, $E = 24$ volts, $R = 900$ ohms, $L = 20$ henrys, $t = \frac{1}{45}$ second. Substituting these values in equation (1) we have

$$C = \frac{24}{900}\left(1 - e^{-\frac{\left(900 \times \frac{1}{45}\right)}{20}}\right)$$

$$= \frac{24}{900}\left(1 - e^{-1}\right)$$

$$= \frac{24}{900}\left(1 - \frac{1}{e}\right)$$

$$= \frac{24}{900}\left(\frac{e-1}{e}\right)$$

$$= \frac{24}{900}\left(\frac{2{\cdot}7182 - 1}{2.7182}\right)$$

$$= \frac{24}{900} \times {\cdot}632$$

$$= {\cdot}01685 \text{ amperes}$$

$$= 16{\cdot}85 \text{ milli-amperes.}$$

It is worthy of notice that in this example that $t = \frac{L}{R}$, so that equation (1) reduces to

$$C = 0{\cdot}632\,\frac{E}{R}.$$

This particular value of t for any circuit is known as the "time constant" of the circuit, and indicates the time taken by the current to reach approximately two-thirds of its maximum value.

Q. 2.—Give a simple diagram showing how the thermionic valve is applied to a wireless receiving circuit, and explain the principle underlying its use as a magnifier.

A. 2.—Figure 1 shows a simple method of applying a thermionic valve to a wireless receiving circuit.

The thermionic valve consists of an exhausted glass bulb containing three electrodes *P*, *G*, and *F*, which are known respectively as the *plate*, *grid*, and *filament*. The filament is heated to incandescence by means of a small battery *A*, and in such circumstances emits a stream of minute negative charges of electricity called *electrons*. Assuming first of all that there is no grid *G* in the bulb, then, if the plate *P* is maintained, by means of the battery *B*, at a positive potential with respect to the filament *F*, it will attract a large number of the electrons, causing in effect a flow of positive electricity

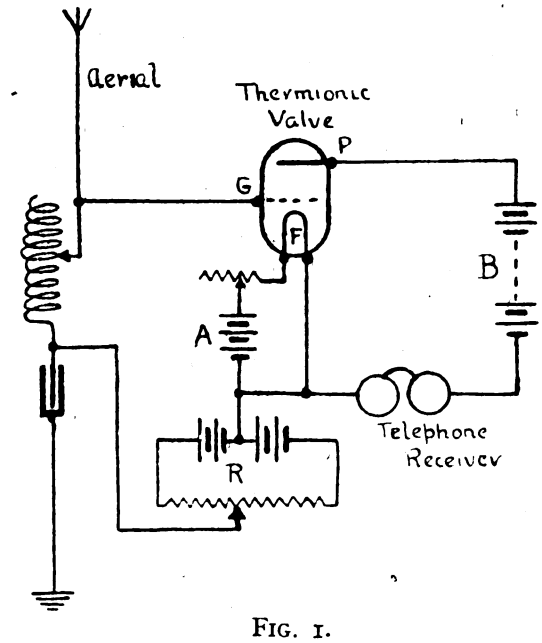


FIG. 1.

from the plate to the filament. Under these conditions the space between the filament and the plate becomes a conductor of electricity, but possesses the peculiar property of conducting in one direction only, viz., from *P* to *F*. The current resulting from the voltage applied between *P* and *F* does not comply with Ohm's Law; up to a certain voltage the rise of current resulting from an increase in the voltage is extremely small, whilst beyond a particular point a very large increase of current is produced by a very small voltage increase. When the voltage applied exceeds a certain value, a further increase produces practically no change in the current; this is due to the fact that the number of electrons liberated per second from the filament is limited, being dependent upon the size of the filament and its temperature. The introduction of the grid *G*, consisting of metal gauze, between the filament and the plate, practically prevents the flow of electrons to the latter; the grid becomes negatively charged by the electrons and consequently tends to repel them, thus shielding the filament from the effect of the positive plate and rendering the valve non-conductive. If, however, the grid-potential is reversed by applying an external e.m.f., its shielding effect will be neutralised and the valve will become conductive, so that a current may pass from the plate to filament through the telephone receiver to battery *B*. Now the capacity of the grid is negligible, so that only an exceedingly small amount of energy is necessary to reverse its potential, and as a result allow a large current to pass through the telephone receiver.

The above is the principle underlying the use of the thermionic valve as a magnifier. When joined up as shown to a wireless receiving set, the grid potential is varied by the oscillating e.m.f. induced in the aerial

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Electric Circuit Theory and Calculations. By MAYCOCK " "	net	7	6
Electric Light Fitting. By BATSTONE	net	6	0
Electric Wiring. By CLINTON	net	3	6
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Continuous Current Motors and Control Apparatus. By MAYCOCK	net	7	6

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Modern Electrolytic Copper Refining. By ULKE	net	13	6
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INDEX TO LETTERS IN BRACKETS.
(a) Out of print. (b) New edition in preparation.

ARE SUBJECT TO ALTERATION WITHOUT NOTICE.

We shall be pleased to supply any of the above books, excepting, of course, those which are out of print, on receipt of price, plus ten per cent. for postage on orders below 5s., and five per cent. if above that amount, and in addition we can strongly recommend the following works, many of which are in regular use by teachers all over the country, and can be supplied on similar terms:—

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		s.	d.
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Elementary Telegraphy. By PENDRY	net	7	6
Telephone Troubles and How to Find Them. By HYDE	net	0	7
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Ditto. Ditto. Final Exams	net	2	0
Text Book on Wireless Telegraphy. By STANLEY 2 vols, each	net	15	0
Notes on Telegraphy. By MOGG	net	2	6
Practical Telephony. By BELL and WILSON	(b)		
Handbook of Technical Instruction for Wireless Telegraphists. By HAWKHEAD	net	7	0
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Elements of Electro-Plating. By SPRAGUE	net	2	6

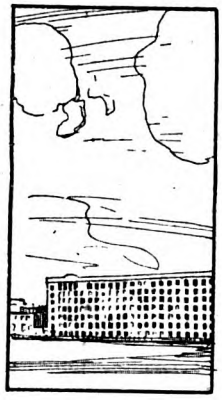
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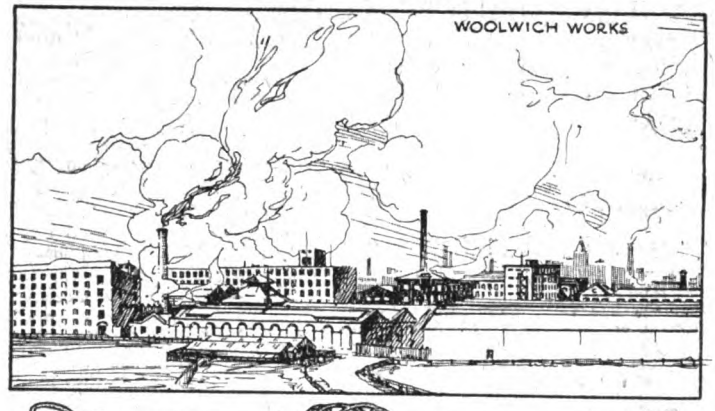
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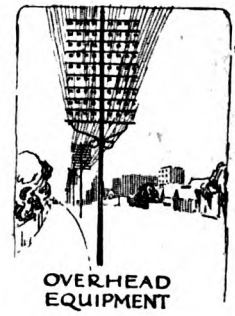
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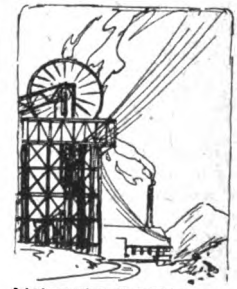
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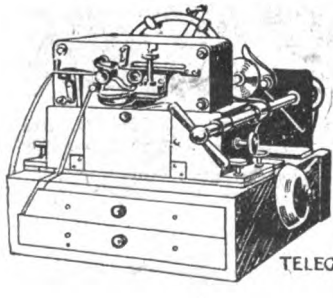
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PRIMARY CELLS

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by an incoming signal. The object of the potentiometer *R* is to allow the initial potential of the grid to be adjusted to such a value that a small change in its potential produces a very large current from the plate to the filament.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 113.

I have received advice to fit magnetic clutches in my machine shop instead of the fast and loose pulleys so necessary for machine operation. Can any reader tell me how these are operated, and what type of clutches I shall require? My lighting voltage is 230 volts.—"PLANER."

QUESTION No. 114.

What are the advantages of shunt motors over series motors for lift operation, or *vice versa*? I am fitting shunt motors to some lifts in the works where I am employed, these being already on hand. Can any reader give me some practical hints concerning operation, controllers, limit gear, etc.?—"FLOOR."

(Replies to Questions Nos. 113 and 114 must be received not later than March 26, 1921.)

The TWO Second Prize Winning answers to Question No. 109 will a pear in next week's issue.

Trade Notes.

An excellent catalogue of the Portable Electric Machinery, manufactured by the **R. G. Haskins Co.**, of Chicago, has been sent to us by Messrs. R. B. Hand & Co., Ltd., of 63, High Holborn, who are the agents in this country. It is beautifully illustrated and describes the various types of electric drills, hammers, buffing machines, etc., in which the Haskins company have specialised for some years. Further, there are some good illustrations of the flexible shaft equipment which is now making such headway in works in this country. The book is sure to interest all users of these tools, and it will be sent free on receipt of trade card, by Messrs. Hand & Co.

At The British Industries Fair, **Messrs. James Pitkin & Co., Ltd.**, Instrument Makers, of 28, Hatton Garden, London, E.C.1, were exhibiting electrical instruments and apparatus of high grade quality, with which the name of the firm has been associated for very many years.

Other exhibitors who were showing goods of interest to the electrical profession were the **"At-a-Glance" Calendar Co.**, of Finsbury Pavement House, London, E.C.2, who specialise in calendars suitable for the electrical and engineering trades; and **Siemens Bros. & Co., Ltd.**, of Woolwich, who were showing their well-known dry batteries as well as lighting sets for bicycles, motor-cycles and motor-scooters; **S. G. Brown, Ltd.**, Victoria Road, N. Acton, W.3, were pushing the "Cyclux," Bicycle Electric Lighting sets; **The Artistic Shade Co.**, 146, Kensington High Street, London, W.8, had an effective display of shades suitable for electric light fittings; **Henry Wolff & Co.**, 13, Bunhill Row, London, E.C., were also showing a goodly assortment of shades for the electrical trade; **The Sheraton Glass Manufacturing Co., Ltd.**, of 36, Victoria Street, London, S.W.1, are the makers of glass tubes, etc., for the manufacture of incandescent electric lamps; **The Vauxhall Glass Manufacturing Co., Ltd.**, had an excellent display of glass electric light shades for both arc and incandescent lamps; and **Geo. Butler and Co., Ltd.**, Trinity Works, Sheffield, who are one of the leading firms in the cutlery trade in this country, and are thinking of putting on the market a pocket-knife which will appeal directly to electric wiremen and all who are connected with practical electrical work.

The ninth edition of Catalogue Section IX. (part 1), embracing Ediswan bells, indicators, pushes, and accessories, has just been issued by the **Edison Swan Electric Co., Ltd.** (Ponders End, Middlesex). It is a comprehensive publication dealing with a large number of types of bells, buzzers, &c., to which the special Ediswan contact pillar is fitted. It will be remembered that this device is so constructed that it is impossible for it to twist or move out of alignment, all contacts being of gold-silver alloy. They are provided on the screw and armature spring.

Revised prices, in nearly all cases much reduced, of M.E.M. standard ironclad switch and fuse gear are contained in advance list, No. 117, March, 1921, issued by the **Midland Electric Manufacturing Co., Ltd.** (Barford Street, Birmingham). "Glasgow" switches are similarly dealt with in list No. 114. Both lists are illustrated and descriptive.

The Bastian Electric Co., Ltd. (185, Wardour Street, W.1), notify that owing to the lower cost of raw material they are able to reduce the list prices of Bastian electric hot-water tanks and accessories by 10 per cent. These Bastian tanks, of which over 200 have been installed, are proving reliable and satisfactory under working conditions. They may be described as slow-running geysers feeding into a heat insulated storage vessel, and the arrangements permit of scalding hot water being always obtainable. There is one heating element (guaranteed for four years) always in circuit, and a supplementary heater which can be switched in on occasions when an extra supply of hot water is required. An illustrated descriptive leaflet is available.

The February issue of "The Link," published by **L. G. Hawkins & Co.** (114/6, Charing Cross Road, W.C.2), follows the general lines of the January issue. An illustrated description of the Patent safety fuse fitted to all "Universal" liquid heaters and a reference to the "Universal" four-heat grill are among the features.

"The Grip. What of Walsall?" This is the title of a brochure just issued by the **Walsall Hardware Manufacturing Co., Ltd.** (Hatherton Works, Ablewell Street, Walsall, and with offices and stores in London, Manchester, Liverpool, Birmingham and Parkstone). Reference is made to the firm's lengthy experience in malleable iron castings, especially at the present time in "channel conduit fittings," with the Walsall Grip, which allows of the rapid erection of conduit installations and at the same time ensures electrical continuity. The company claims to manufacture the largest and most complete range of conduits and fittings—plain, screwed and grip. The brochure in question is an interesing piece of propaganda literature.

"Witton" D.C. motors and "Witton" A.C. single-phase and polyphase induction motors, in sizes up to about 125 h.p., are listed in new editions of the **G.E.C.** Catalogue, sections P(3), 13th edition, and P(4), 13th edition. A general and technical description, together with specification and dimension drawings, is given in each case.



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Various Items.

Lurgan.—The tender of the Enfield-Ediswan Co. being the lowest for the supply of cable for the lighting and power scheme, has been accepted. Delivery to be given within 14 days.

County of London E.S. Co.—As a result of a good year, larger amounts are credited to reserve and depreciation, while a dividend of 8 per cent. for the year on the ordinary shares is to be declared.

English Electric Co.—Mr. Walter Rutherford has resigned from the board and management of the English Electric Co., Ltd., Mr. P. J. Pybus, Joint Managing Director, has been appointed Managing Director.

Personal.—Messrs. H. W. Smith & Co., Ltd. (1920), Electrical Wire and Cable Manufacturers, of Lydbrook, Glos. and Central House, Kingsway, London, W.C.2, have appointed Mr. J. S. Dyas, of 63, Dawson Street, Dublin, as their representative in Ireland.

Henley's.—The accounts show that a profit of over £240,000 was made in 1920, and the directors recommend a final dividend on the ordinary shares of 2s. per share, making 3s. for the year. An increased carry forward of £183,537 is made. The company appears to have had a very successful year.

Social.—The fourth social evening of the Ediswan Bristol staff and their friends was held at the Company's Showrooms, on the 2nd inst. An attractive and entertaining musical programme had been arranged and was much appreciated by the audience.

China.—Hsin Chang, a small district in Pootung, is to have its own electric light and power plant, according to recent announcements in the Chinese press. The housing for the plant is nearing completion, and all the poles have been set and the wiring completed.—*Millard's Review.*

Newark.—The T.C. has decided to apply for a Provisional Order for a supply of electricity, application having been first made as far backas 20 years ago. As a result of having no supply the town has not progressed, many firms inquiring for sites having gone elsewhere.

Pretoria.—Tenders for switchgear for the Municipality are required by May 10. Specification, &c., from the Town Clerk, on deposit of 5 guineas, and particulars from the General Manager, E.L. and P. Department, or from the Consulting Engineer, Mr. G. M. Clark, 40-2, Meischke's Buildings, Johannesburg.

New Council of the E.D.A.—The new Council and Executive Committee of the E.D.A., elected to date, contains a large number of well-known pillars of the various interests represented, so that we are justified in anticipating important developments in the near future for the benefit of the entire industry. Those not familiar with the constitution of the Council may be reminded that representatives of the following are included:—I.E.E., B.E.A.M.A., I.M.E.A., Conference of Chief Officials of Lond. E.S. Companies, Inc. Association of E.P. Companies, Prov. E.S. Companies of the U.K., C.M.A., E.L.M.A., and E.C.A.

Exhibitions.—Hereford and Worcestershire Agricultural Show is to be held at Hereford, from June 7 to 9 (inclusive). The E.S. Undertaking contemplates arranging a suitable display of electrical apparatus, with an electrical café, etc.—An electrical exhibition is to be held in the Town Hall, Aylesbury, from 21st to 24th inst. Practical demonstrations of the use of electricity in the office, institution and home will be given and electric lighting sets, electric vehicles and small farm plants will be in operation. Mr. J. W. Beauchamp (E.D.A.) will lecture on Tuesday, 22nd inst., on "Electricity in the Home," and Mr. W. T. Kerr (of Hereford) on Wednesday, 23rd inst., on "Electricity in Agriculture."

Electricity Districts.—The time during which representations in connection with the proposed N.E. Midland District may be made has been extended till June 30. Progress in the providing of cheap and abundant electricity as promised by the Government seems to be lamentably slow in all cases. Rivalry and bickering concerning control and administration are being carried on with all the pre-war bitterness, while the obstruction to reform and businesslike methods is as bad as ever on the part of Local Authorities. Why not give Power Companies supreme authority, subject to adequate safeguards, which could easily be devised? Rapid improvement would at once manifest itself.

Burnley.—The Finance Committee have decided to levy a special rate of 5d. in the £ for the Corporation tramways, which last year showed a loss of £12,000.

Bradford.—Mr. A. J. S. Waddell (Manchester) has been appointed generating engineer at the Valley Road Electricity Works here, at a salary of £500 per annum.

Blackpool.—In the extensive alterations to the Grand Theatre, the new electric light fittings were supplied by the Edison Swan Electric Co., Ltd., through their Liverpool branch.

Darwen.—The T.C. has applied to the Commissioners for sanction to borrow £1,524, to extend electricity mains. The Council have approved the agreement for the supply by Blackburn Corporation of electricity in bulk to Darwen. The construction of mains has already been undertaken.

Meetings.—The annual general meeting of the Batti-Wallah's Society will be held immediately after the usual monthly luncheon, on March 21, at the Holborn Restaurant. Among the items on the agenda are the election of the President, Officers and Committee for 1921. The annual dinner, to which ladies can be invited, will be held on April 8.

Blackburn.—Arrangements having been made with the Corporation for an additional supply of electricity, cables are now being laid in Darwen. Two extra high pressure cables—of the lead-covered and heavily armoured type—are being placed underground from the electricity works to the borough boundary. Either cable can be used independently of the other.

Fibre Productions for Canada.—H.M. Trade Commissioner in Canada report that a Winnipeg firm of manufacturers' agents are desirous of getting in touch with U.K. manufacturers of fibre productions for electrical apparatus who wish to place their goods on the Canadian market. Further particulars from Department of Overseas Trade, 35, Old Queen Street, London, S.W.1.

Skipton (Yorks).—The Craven and District Private Telephone Co., Ltd., here have entered into a contract with the Keighley Corporation for the supply of electricity at 6,600 volts (from Keighley) to Eastburn. The immediate purpose is to supply current to Messrs. Dixon's stone quarries, near Eastburn, but it is understood that eventually the system will be extended to Eastburn village, Crosshills, Steeton and Silsden.

Blackpool.—The Corporation has now a fleet of 131 electric tramcars, included in which is the first car which ever ran in the town. This is the oldest in the country and is in use by the engineering department.——The Electricity Department is booked up with service work for three months ahead, and it has been decided not to accept for the present applications for supply which involves extensions of the main or where a supply of gas is already available.

Prize Competition.—The St. George's Engineering Co., of Brearly Street, Birmingham, have opened a competition for turners, fitters, foremen, etc., who send in the best short description (with rough sketch) of the most unusual or interesting work they have done when using a gear scroll chuck. The prizes to be awarded are:—First prize, £5; second prize, £2; and third prize, £1. Further particulars on application to the company, mentioning this paper.

Dundee.—The T.C. have a report by Professor Gibson, Manchester, and the City Electrical Engineer on the question of obtaining electric current for Dundee by water-power. The present steam plant may soon become inadequate to the requirements of the city. Hydro-electric energy could be obtained by purchase from the Grampian Electricity Supply Co., or by development of the Ericht-Tummel scheme. The approximate capital expenditure of the Ericht scheme would be £1,100,000. For an output of 50,000,000 units per annum, the cost would be 0.50d. per unit. The united capacity of the present steam station and the hydro station would be 110,000,000 units per annum.

Burnley.—At the Bankruptcy Court, on March 10, Albert Lord, carrying on business at 33, Westgate, Burnley, as electrical contractor, underwent his first public examination. The liabilities were £977 2s. 6d., and assets £52 5s. 5d. The cause of failure alleged by debtor was "heavy household expenses." Debtor said he did not think the profits on his business were ever equal to his household expenses. He commenced without capital, and did small jobs at first, but later took a £565 contract, from which he allotted £250 to a Manchester firm for materials. He lost money on that work. That was one of the reasons for his insolvency. He denied selling off his stock quickly just prior to filing his petition. The examination was closed.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
MARCH 25, 1921.

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A UNIQUE G.E.C. SLOW SPEED ALTERNATOR FOR WATER TURBINE DRIVE.

A three-phase 1750 k.v.a. alternator to work at a power factor of .8 with a normal working pressure of 5,200 volts 50 cycles has recently been manufactured by the General Electric Co., Ltd., at their Witton Works for the St. John Del Rey Mining Co. The machine (Fig. 1) is designed for coupling to a water turbine running at a speed of 187.5 r.p.m. As it had to be transported to the far side of the Andes, and would therefore be subjected to difficulties of transport, while only a 5-ton crane was available on site, no separate piece could exceed 5 tons in weight. This fact necessitated the stator being built in four sections each with four pole pairs, the winding for each section being complete.

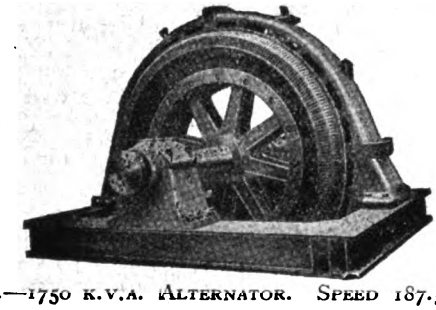


FIG. 1.—1750 K.V.A. ALTERNATOR. SPEED 187.5 R.P.M.

The rim of the pole wheel is solidly constructed. It consists of four cast steel rings, the poles, which are built of steel laminations, being dove-tailed into the centre two and held in position by taper keys. The two rings are carried on a cast iron spider, and secured by means of taper keys which are driven in horizontally, from opposite sides. In order to guard against the effects of expansion due to the centrifugal action of the wheel, two precautions are taken. First, the dividing plane between the two keys is vertical; and secondly, securing screws pass through a flange on the extremity of the spider arms into the rings. These screws are provided with strong spring washers under their heads. The two outside rings which are screwed firmly to the centre rings and spigotted into them are necessary in order to produce the total flywheel effect, namely 1,420 tons-feet. The whole rotor structure is attached to the shaft by means of tangential keys.

The field coils are wound with copper strip on edge, insulating strip being inserted between the respective turns. They are then securely fastened between gun-metal clamping plates. The complete coil is rigidly fixed to brackets on the side plates of the poles by set-screws which pass right through to the rim of the wheel, and thus prevent lateral movement.

Copper rods embedded in slots in the pole shoes and riveted into heavy bronze end-plates form a damping winding. Each section is linked to the corresponding section on the next pole, thus providing a continuous ring round the field system.

As the machine had to be shipped abroad it was essential to carry out exhaustive tests at the works. The guarantees given as regards electric performance related principally to (1) temperature rise, (2) efficiency, (3) overspeed, and (4) wave form.

As only one machine was available a Hopkinson test was not possible, but a method of testing the machine on full load was therefore devised, the main principle being that the reversal of a certain number of stator coils in one phase of a mesh connected stator winding causes a disturbance of voltage balance. A current therefore circulates in the mesh circuit, and by suitably choosing the number of coils to be reversed, full load current will flow at full voltage.

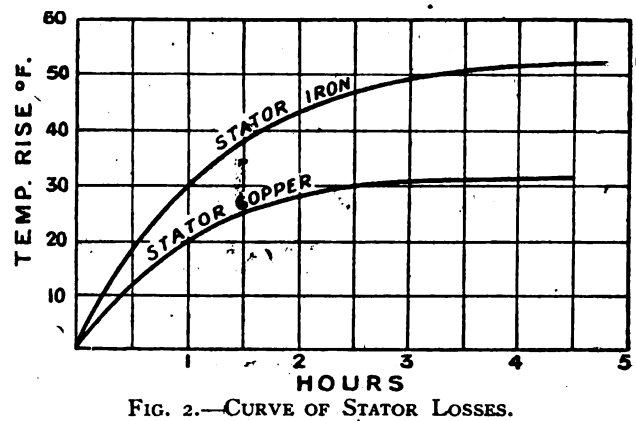


FIG. 2.—CURVE OF STATOR LOSSES.

When run under full load conditions as just described temperature curves were obtained as shown in Fig. 2, the efficient ventilation of the machine is shown by the fact that it took only four hours to reach steady temperatures.

To ascertain the efficiency of the machine the losses in the generator were obtained by measuring the various losses separately, and the result was checked by the power required to drive the machine when running under load conditons. The curve in Fig. 3 shows friction, windage

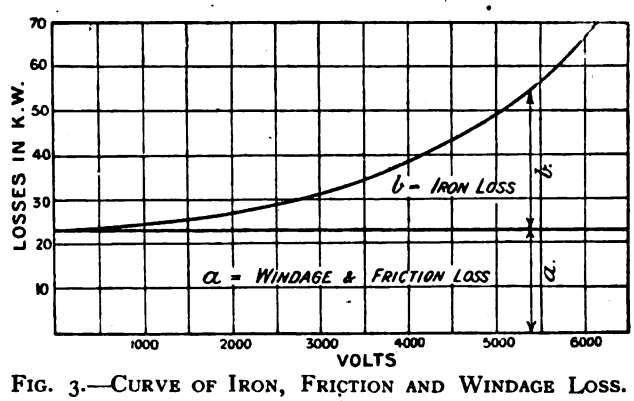


FIG. 3.—CURVE OF IRON, FRICTION AND WINDAGE LOSS.

and iron losses, obtained by measuring the energy taken by a D.C. driving motor, first with the alternator unexcited, and then at various excitations. The overall full load efficiency was 93.3 per cent. compared with a guaranteed efficiency of 93 per cent.

As the machine was to be driven by a water turbine and might be subject to a large increase of the normal speed in case of sudden load fluctuation, the generator was

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run at an overspeed of 80 per cent. for 15 mins. to demonstrate the mechanical strength of the rotor construction.

In view of the fact that the alternator has to supply power through a 30,000 volt transmission line, a true sine wave form of the voltage without any ripples is of great importance. But the stator winding had to be insulated with seamless mica tubes on account of the high voltage;

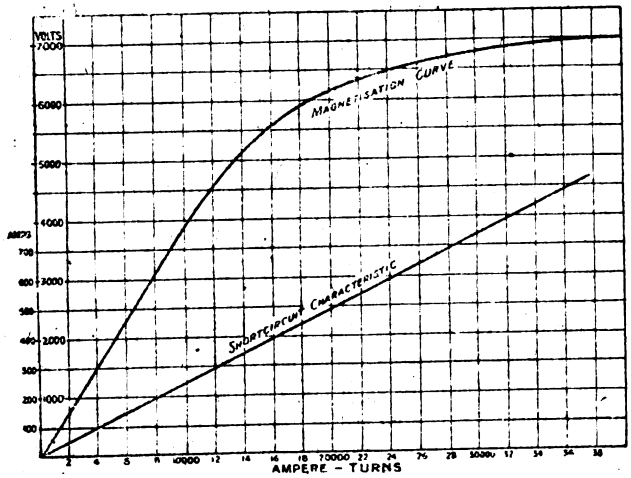


FIG. 4.—MAGNETISATION CURVE.

for this reason, and also to facilitate repairs on site, it was essential to construct the stator with open slots. Such slots often produce tooth ripples in the wave form of the voltage curve. To overcome the setting up of such ripples the number of stator slots was made more than twice the number of stator coils, a few of them not having windings inserted in them. By correctly choosing the number of these additional slots and by suitably shaping the pole shoes, a perfect sine wave form of the voltage was obtained.

LOW-TENSION CABLE BREAKDOWNS.

BY G. W. STUBBINGS.

One of the most important and gratifying of the results of standardisation and of industrial research undoubtedly consists in the great reliability of modern cables. The reliability of cable systems, however, is not only dependent upon the goodness of the actual cable used, but also, to a very large extent, in underground systems, upon the design of the jointing accessories, and also upon the standard of jointing work. The design of cable for ordinary distribution work is now practically standardised. The solid system, in spite of the great reliability that was claimed for it, and expected of it at the time of its introduction, has proved itself to be perhaps one of the most unsatisfactory systems evolved, and is now for new work practically obsolete. The system in which low-tension distributing cables were drawn into conduits has also passed out of use for new work, although low-tension feeder cables are frequently installed on this system. The method of laying cables which has proved itself to be the cheapest as well as the most reliable is that of laying the cable direct in the ground. Such cables must obviously be of the lead-covered variety, and must be further protected by compounding and taping. The usual practice is to give further protection in the shape of steel tape or wire armour, but, according to Mr. Gillin, unarmoured extra high-tension lead-covered cables have been laid direct in the ground at Bradford, with, at present, quite satisfactory results.

The standardisation of cable design and cable-laying practice, satisfactory as it is, has not been followed up by a corresponding standardisation in the design of jointing accessories or in methods of jointing. With 3- and 4-core low-tension cables there is a growing tendency to enclose all joints, both straight and tee, in lead sleeves, these sleeves being wiped on to the cable in the usual way. Such practice is of the highest and gives a great degree of reliability, but calls for a high grade of jointer. The lead sleeve system is also applicable to concentric mains, but offers greater difficulties and calls for a more skilful jointer than in the case of 3- and 4-core cables. In spite, therefore, of the excellence of the lead sleeve system, the cast-iron joint box is very largely used both for straight joints and for service tee joints. A further discontinuity in the cable system is found in the network box or the network pillar, and in these devices a greater diversity of design is found than in the practice regarding buried jointing work. Lack of standardisation in these details means that the question of the best design is still an open one, although naturally every distribution engineer has his preference. Individual preference is, however, founded upon individual experience, and is not to be compared with the standardisation of a design that is the result of the aggregation of the combined experience of the whole of a particular branch of electrical engineering.

Summarising the present position, it may fairly be said that at the present time the reliability of cables is as high as can reasonably be expected, the reliability of jointing work, however, owing to lack of standardisation of practice and to the fallibility of the jointer, being of a much inferior order. Accordingly joints are, and for a long time will be, a source of potential weakness in any cable system.

If this applies to jointing accessories of the present time and to jointing work, it applies with greater force to joints and jointing of twenty years ago, when so many supply systems were inaugurated and when so much cable was put away in the ground. The reliability of most of the systems in operation at the present time has for one of its factors the reliability of a good deal of old work that was carried out when basic principles were not as well known as they are at present.

The causes of breakdown in low-tension distributing systems are relatively few and can be roughly classed under the heads of mechanical damage, and deterioration of insulation owing to the presence of water—the primary cause of this latter being generally bad jointing. The mains engineer in charge of a system laid down within the last ten years in which the work was of the highest, and the methods up-to-date, should be a happy man. It is the use in the early days of the majority of undertakings of badly designed accessories, and the work of the old school of jointer, that go to make the possibility of a fault one that has to be, and that will have to be, reckoned with for a long time to come.

The effect of a cable breakdown may not necessarily be an interruption of supply, but it is usually essential that the faulty length of cable be isolated at any rate to the shortest length that can be obtained by disconnecting. In many cases the fault will shut down a whole area by blowing fuses in a sub-station or a feeder pillar, and then the isolation of the bad length is a matter of urgency. Ability to deal with cable breakdowns depends partly on experience and knowledge, and partly upon the possession of a cool head. The young engineer of rather excitable temperament who has to tackle his first fault is not a person to be envied. After he has dealt with twenty or so he will possibly find the matter a good deal easier, but undoubtedly the urgency of the matter and the fact that consumers are deprived of their supply make the isolation of a fault a rather strenuous time to all engineers, excepting, perhaps, that particular type who enjoys a bit of trouble.

The effect of cable breakdown upon the supply to consumers depends largely upon the system of supply and upon the type of cables used. The system offering the largest possibility of carrying on the supply is that employing 3-core cables or three single cables with direct current. In direct current 3-wire systems it is customary to earth the neutral main through a limiting resistance which can stand the outer to neutral voltage. In such a system, should the positive or negative conductor go to earth, the potential of that main will determine those of the other two, and the neutral will then be charged to the supply voltage. A limited current will then pass through the

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fault, this current being, assuming that the insulation of the neutral main is sound, the current sent through the earthing resistance. The state of affairs then prevailing does not necessarily mean that any main will be shut down. The neutral, however, is charged to the supply voltage, and the sound outer is at double normal voltage from earth. Apart from the fact that double voltage is usually dangerous, the state of affairs is a severe test to the insulation of the whole system, and at any moment a second breakdown may take place, the effect of which is, of course, a short circuit. An earth, therefore, requires to be cleared as soon as possible. With three single cable, a breakdown usually takes the form of an earth, at first, at any rate, although the burning at the fault, due to the passage of the current in the earthing resistance, may soon spread the trouble to the other cables. The same may be said of an earth on a 3-core cable, except that in this case the trouble is likely to spread sooner and develop into a short circuit. Earths can also occur on the wiring installations of private consumers, but such earths can usually be cleared, except in the larger installations. Earths are rare in triple concentric systems, as in such cables the live mains are surrounded by the earthed conductor till these conductors are well inside the joint boxes, and a breakdown of a live main will therefore invariably be a short circuit.

With low-tension alternating current supplies it is usual to connect one conductor of the system to earth by means of a solid connection and without any fuse or limiting resistance. When this method is used earth shields between the high and low tension windings of the transformer can be dispensed with, but an earth anywhere on the system necessarily becomes a short circuit. The effect of a short circuit is to blow the lightest fuse between the fault and the central station busbars. This is the theoretical effect, at all events, although it may happen that with a severe short circuit two fuses, or a fuse and a circuit breaker, may open. If the earth be on a consumer's installation, his fuse will be taken and the interruption of supply will be his concern alone. If, however, the earth or short circuit be on a distributing cable, the fuse at the sub-station or feeder pillar will be blown, and all consumers fed from that fuse will have their supply interrupted.

The extent of the area of supply affected by a cable fault will largely depend upon the closeness with which the distributing network is linked up, or, in other words, upon the number of open points. In the case of a town fed from one central station, if the whole of the network is linked up solid, a distribution fault will—unless it burns itself clear—blow one fuse after another, and may shut down the whole supply. In the interests, therefore, of continuity of supply to consumers generally, and of confining the effect of a distributor fault to as small an area as possible, it is advisable for each feeder to feed a definite area, such area being either disconnected to adjacent areas or only connected thereto by light fuses that will instantly clear the fault conditions. The principle of sub-division can be carried still further with great advantage by arranging that each distributor from a feeder pillar or sub-station feeds an isolate area or one only connected to adjacent areas through light fuses as with the feeder areas. With a network so arranged a distributor fault will only shut down the distributor feed by which it is supplied, and the remainder of the network will be unaffected. It is to be remembered, of course, that to run with open disconnecting faults means that the copper in the mains is not used to the best advantage. Between any two feeds from sub-stations there is a point, or are a number of points, at which the flow of current is zero, and if these points were fixed the section between neighbouring areas would be made there. Unfortunately the position of this point is not constant but varies with the load, so that even if a position correct under peak load conditions is chosen, this position will not be correct for other times of the day when the local loads may be heavy, notwithstanding the load on the station is relatively light. The use of fuses across section points corrects this disadvantage in that the small balancing currents can flow across these points. Fuses in network boxes are, however, a great nuisance, except when the box is especially designed for them. It might be thought that the correct method would be to install fuse disconnection boxes at the section points so that the copper in the distributing system could be used to the best advantage. As time goes on, however, and the network is extended, and the number of consumers increases, the position of the section point may alter. Each case must be decided on its merits, but it may be said that it is as well to run with open section points if possible, as this will ensure that a distributor fault will affect the smallest possible area.

The occurence of a fault on a system with one main solidly earthed will, it has been seen, result in a short circuit, and will blow the nearest fuse. The faulty main is located by splitting up the section at the various disconnecting boxes. The dead section is first divided into two halves, and the half fed from the pillar is tried with a light fuse. Should this fuse stand, the fault will be in the other half, and the sound section can be made permanently alive. The second section is then cut into further two sections at a suitable disconnecting box, and a second trial is made at the disconnecting box first opened. This procedure is repeated till the fault is isolated to the shortest length that can be isolated at disconnecting boxes. Should the first test show that the half area nearest the pillar is the faulty one, the half remote from the pillar can be made alive at one of the disconnecting boxes which divide it from neighbouring areas. The choice of the points at which the network is split will depend largely on the loading of the network. If, for instance, a small residential area is shut down, and on the distributor feed from the feeder pillar, and near to it, there is an important power consumer, one would naturally go to the nearest box past the power consumer, as there would then be a good chance of getting this consumer on again quickly.

For testing distributor sections, either from a sub-station or from a live terminal in a disconnecting box, every mains department should possess some sort of portable test box. This set, if well made and designed for convenience, will not only enable the isolation of the fault to be carried out in comparative comfort, but with greater speed. Such a set can be made by mounting a 50 ampere handle-type fuse, together with a knife switch, in a box provided with a handle made of a piece of 1-inch leather belting. If the box can be divided by a partition into two cubicles, each with a separate lid, and the fuse and switch be isolated from each other, the arrangement will be a godsend to the highly strung individual. A further refinement consists in the provision of a coil of stout resistance wire, wound, say, round a strip of Uralite, this addition being similar to the choking coil in the "Bradshaw" test fuse. The effect of even a short length of resistance wire on direct current faults is quite noticeable, in that a short circuit that has blown a 200 amp. fuse in the feeder pillar with explosive violence, will blow a 22-gauge copper fuse in the test box relatively quietly. The effect is even more pronounced on A.C. faults, and the inductance of the coil is appreciable, and the choking effect on the short circuit current correspondingly increased. It need hardly be said that the leads from such a test box should be thoroughly insulated, and no better cable than C.T.S. can be used.

It has been pointed out above that on direct current three-wire systems, with a limiting resistance in the neutral earth connection, an earth on a live main will not necessarily shut down a section, but will increase the potential of the other live main to approximately twice its former value. The supply can, in these circumstances, be continued while the fault main is being found and isolated. The method of isolating such a fault which is of the widest application requires duplicate sets of busbars and balancers. When such are available at the central station the whole network must be divided into two sections, the neutral mains being disconnected as well as the outers. The second set of bus-

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bars, with its balancer and earth connection to the neutral, is now made alive, and one half of the network is transferred to it. An inspection of the two earth ammeters shows at once on which section the earth is. One feeder section of the faulty half is transferred at a time to the busbars feeding the sound half, and by this means the section containing the fault is thus found. By transferring portions of the network successively from the bad to the good sections it is possible to isolate to the shortest length without any interruption of supply. This would be an exceedingly tedious matter and would involve constant touch between the central station and the man changing the links in the network boxes. This method is also applicable to large direct current systems fed from a number of rotary sub-stations. In such circumstances the neutral conductor is usually disconnected normally at the open points, there being a separate earthing connection and earth ammeter in each sub-station. The conditions in this case are precisely similar to the duplicate busbars at the central station, except that the duplicate bars are now located some distance apart. The method of transfer is the same and will enable the fault at any rate to be traced down to a relatively small area without interruption of supply.

When duplicate busbars are not available other and cruder methods have to be resorted to. One method is to split the district up into feeder sections if this is not the normal condition, and to earth the sound main at the works through a comparatively low resistance so as to pass as large a current as practicable. This current will return to the other busbar through the fault and along the feeder supplying the faulty section, and by watching the feeder ammeters whilst the sound busbar is "flashed" through the low resistance, it is often possible to observe a kick on the feeder ammeter. If this indication is definite one half of the bad section is now transferred and the test again tried, when it will be observed whether the fault has left the original feeder. By repeating this test the breakdown can be traced as before to as narrow limits as may be desired.

The foregoing method is of little use when the load on the feeders is fluctuating, as in these circumstances it is not possible to distinguish between the kick occasioned by flashing and the fluctuations of the ammeter pointer due to variations of load, unless an inconveniently high flashing current is used. It is often advisable to wait till the load on the system has got sufficiently small to allow of the feeder switches being opened momentarily. If this be done the faulty area will be detected at once by the removal of the fault current through the earth ammeter, or, better still, by observing the behaviour of a set of earth indicating lamps. These lamps will, it will be remembered, be half bright and half dark under fault conditions. The momentary removal of the fault when the switch in the feeder connected to the defective section is opened will cause an unmistakable blink in the bright lamps. The fault can be further traced by transferring as before, but this tedious process can be obviated by proceeding to the pillar or sub-station fed by the feeder to which the fault has been traced, and connecting a set of test lamps—two in series will suffice—to the busbar at high potential. These lamps will light at full voltage, and by momentarily removing the fuses to each distributor feed, the fault can be traced to an individual feed by the fact that the withdrawal of the fuse to the faulty section will cause the voltage on the lamps to diminish to one half. This assumes, of course, that the areas fed by the several cables from the feeder pillar are all isolated; if this is not the normal conditon, the feeder area must be split up. The faulty section can now be divided in precisely the same fashion as when testing for a short circuit, except that in this case it will be advantageous to proceed direct to the network box that divides the area in two parts, and momentarily throw dead the section remote from the feeder pillar, the lamps, as before, being connected between the high potential main and earth. The disconnection of the faulty cable will cause the characteristic flicker of the test lamps. Should the fault be on the section remote from the feeding point, further divisions can be made till the shortest length is isolated. It need hardly be said that with this method of testing it is necessary merely to withdraw momentarily the fuse or link on that side of the system on which the fault is.

Having isolated the shortest possible length of faulty cable, it remains to be decided what further action can be taken. In the case of an earth fault, without interruption of supply, it is sometimes possible to loop the positive and negative cables together on the faulty length and connect then to the neutral main, the neutral cable being made alive through a temporary fuse. This will remove the earth from the system and will give a supply to all domestic consumers. A number of meters will, however, be reversed, and any power consumers across the outers will, of course, be deprived of the high voltage supply. In the case of a short circuit, when the shortest length is isolated and the supply completely restored to all sound cables, the question arises as to whether a localisation test is to be attempted at once, or whether it is advisable to cut the cable once or twice to get more consumers on. This question will be decided largely by the type of load supplied, and in the case of a distributor feeding a number of shops it is often advisable to cut two or three times, the position of the cuts again being decided by the distribution of the load and the class of the various consumers rather than by a merely arithmetical basis of half way. If, on the other hand, the consumers are not deemed to be of great importance, or if the cable is known to be in a comparatively inaccessible position—under the road, for instance—it may be advisable to proceed at once to a test.

The amount of purely technical knowledge required to isolate a faulty distributor length is surprisingly small, the chief qualificatons being common-sense, a cool head, and an intimate knowledge of the network. Experienced mains engineers usually pride themselves upon the latter, and the young engineer who is taking up distribution work cannot do better than endeavour to get as accurate and detailed a knowledge of the cable network he has to do with, as he possibly can, for this knowledge will be of unspeakable assistance to him when he is called upon to tackle his first fault.

UNIFICATION OF L.T. PRESSURES IN SWITZERLAND.

To secure obvious economies in the manufacture of electrical apparatus, and to facilitate standardisation, the Swiss Association of Electricians recently decided to adopt 125, 220, and 380 volts A.C., and 110, 220, and 440 D.C. as standard electrical pressures at consumers' terminals. Various aspects of this decision, such as methods of converting existing plant, adaptation of new standard apparatus to non-standard systems, etc., have been discussed in recent issues of the Association's Bulletin. In the present number Dr. Wyssling deals with interchangeable connections for transformers and motors, and with the relation of generating pressures to the standard consumers' pressures. It was also proposed to adopt a medium pressure of 760 v. as a sub-standard, for use where too much disadvantage would attend the use of the lower pressure of 380 v. It is now considered, however, that the sub-standard medium pressure should be $\sqrt{3} \times 380 = 650$ v., as lending itself better to the standardisation of motors and transformers. Motors made for 650 v. star connection could then simply be connected in delta on a 380 v. system, and star-star 650 v. transformers would simply be reconnected star-delta for 380 v. On the other hand O. Ganguillet argues against the standardisation of a medium pressure in any form, asserting that there is no need, from the point of view of machine design, of any intermediate voltage between 3,000 v., the lowest standard h.t. pressure, and 380 v. (Abstract in *Technical Review* from *Bulletin, Schweiz. Elektrotechnischer Verein.*)

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PAGES FROM OUR DESIGNER'S NOTEBOOK

WESTON ELECTRICAL INSTRUMENT CO LTD

THE WESTON INSTRUMENT ON FLUCTUATING LOADS.

A TEST THAT DEMONSTRATES THE VALUE OF CORRECT DESIGN.

On commercial circuits the load is continually and often abruptly changing in value, and an instrument that cannot follow the changes without a serious sacrifice in accuracy and facility of reading will be of little assistance in the efficient operation of a plant.

To indicate the true conditions under fluctuating load an instrument must have a high ratio of working torque to weight of the movable system, and it must be effectively damped.

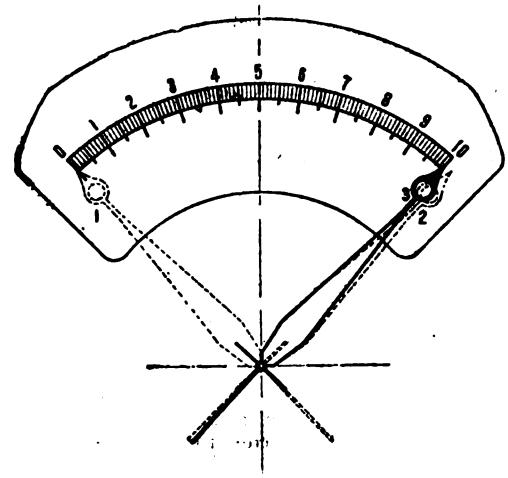
High torque instruments should be regarded with suspicion, as high torque alone signifies great weight and therewith large friction torque and inferior durability. The correct method—which is employed in all WESTON instruments—is to provide a high ratio of torque to weight, and this is effected by reducing the weight of the movable system to the lowest limit and by properly distributing its mass.

In result, WESTON instruments may be read with accuracy even on widely fluctuating loads, and the degree to which this is possible is brought out very strikingly by the following test.

Starting from no load a sudden application of full load produced a total overswing of only two divisions as shown in the diagram, the numbers on which indicate the successive positions of the pointer.

In this test, which is the most severe that can be applied to an instrument, it took the pointer just two seconds to come to perfect rest. The instrument could easily be made absolutely dead beat, but a slight overswing is desirable to show that the movable system is free from friction.

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DAMPING TEST ON MODEL 167 WATTMETER.

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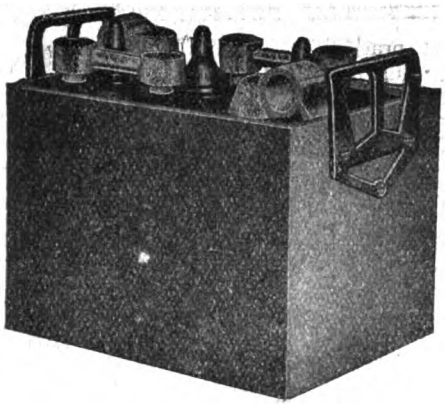
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" " 15	105	12¼ " " "
12 volt " 7	45	12¼ " " "
" " 9	60	15¼ " " "
" " 11	75	17¼ " " "

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THE

TELEGRAPHISTS' GUIDE

To the P.O. Departmental and City and Guilds' Exams.

By JAMES BELL and SAMUEL WILSON

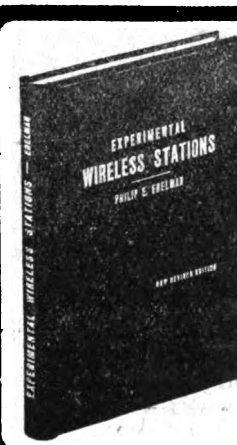
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning,** in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

A Turbo-Electric Cargo Vessel.

Readers interested in the application of electricity to marine propulsion will be pleased to hear that the first electrically propelled cargo steamer, the *Eclipse*, of 11,863 tons, has reached Java, after a very successful run. Built in San Francisco in 1918, the *Eclipse* had her original steam engines and associated gear removed last summer and the turbo-electric plant substituted. Her present equipment consists of a steam turbine and 2,300-volt generator, which drives a 3,000-h.p. motor at 100 r.p.m. According to report, the first stage of the trip, a non-stop run of 5,122 miles to Port Said, was the most interesting. Although heavy weather was experienced, and the staff on board were handicapped by a poor grade of fuel, excellent speed was maintained. The main turbine motor gave excellent service, the control gear was very easily and efficiently operated, and not the slightest trouble of any kind was experienced during the run. The *Eclipse* is expected back in America in July.

The Limitations of Electrical Text Books.

In an editorial, my Chicago contemporary, the *Electrical Review*, comments on the air of finality which is associated with almost any text book on electrical subjects, even those standardised works used and recommended by the various educational institutions. Text books, as a rule, are not revised every year; there is more frequently a gap of several years between the appearance of one edition and the next, during which period much rapid and important progress has probably been made in the field with which that particular book treats, and the student, who depends largely upon it as his source of information and ready reference, finds out too late that he is hopelessly out of date.

It is a fact that most writers on technical matters, and electrical subjects in particular, are too prone to labour the elementary principles pertaining to that particular branch upon which they are writing, and to pad their early chapters with overmuch past history which simply clogs the brain of the progressive student. Moreover, their closing chapters generally partake of the nature of a grand finale to the whole subject, as if the writer had recorded all that had been accomplished, or was ever likely to be accomplished, for the next decade. It would be a decided advantage if well-known technical authors treated their subjects on the lines of the serial novel, each succeeding edition being a step in advance of the last one published, and, as it were, commencing with the evolution of the subject from the point where it was broken off in the preceding volume. With the present practice of periodically revising well-known text books at long and irregular intervals, the student is apt to miss very vital and important subject matter which the author has unintentionally omitted or considered of insufficient importance to include in his work owing to limitations of bulk and paging imposed by his publishers. Until the existing system of text book issuing is very radically revised the student's only hope is the technical journals. Every engineering or technical student should become a regular subscriber and reader of the leading trade journals associated with his particular branch of industry. Such journals perforce have to be up to date in order to maintain their circulation, and, by a careful study of their pages week by week, the blanks left in the text-book curriculum can usually be filled in.

Automatic Lighthouses.

The romance of the lonely lighthouse keeper will soon be a thing of the past. Automatic lighting and control has now been brought to such a pitch of reliability that in most cases it is no longer necessary to maintain an attendant in lonely state on island rocks, far from the mainland, to keep the lamps going and ensure an efficient warning signal every night all the year round. The disappearing lighthouse keeper is another sign of the times in the matter of replacing human labour by automatic machinery, one of the reasons for the change in policy on the part of Trinity House being the present high cost of maintaining staffs at these isolated stations. In any event a lighthouse keeper's job was not the kind of employment for a physically fit man, fond of the companionship of his kind, and the substitution of electro-mechanical methods will probably be just as welcome to the fraternity as to those responsible for maintaining the safety of our coastline.

Tapping the Main.

A recent prosecution at Stoke, which led to a man being heavily fined for unlawfully abstracting electrical energy from the mains on the supply side of the meter, once more directs public attention to the prevalence of this fraudulent practice, and exemplifies the difficulty of detection. There have been many similar proceedings against offenders in various parts of the country, and, according to supply authorities, quite a considerable amount of undetected pilfering goes on of a like nature in which the offenders are never brought to book. To anyone with even a smattering of electrical knowledge it is such an easy matter to establish satisfactory connection with the conductors in the cables leading into the usual house service meter, on the street side, and thus obtain an unlimited supply of energy at 0d. per unit.

The remedy would appear simple, and it is rather surprising that supply authorities have not generally adopted it hitherto. One seldom or never hears of a similar complaint in connection with the public supply of gas, mainly because the tapping of a gas service pipe is not so easy of accomplishment as the piercing of a comparatively thin layer of rubber, paper, or bitumen insulation. To tap a gas supply pipe involves some experience of gas-fitting or pipe work, and it is usually difficult to make such a connection without leaving tangible evidence of the fraud. If electricity

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supply services were led right into the body of the meter by way of screwed conduit, they would be similarly immune from unauthorised interference, and I commend this method to the notice of all supply authorities who have suffered the depredations of the current sneak.

Long-Distance Telephony.

Few readers, except those directly connected with the public telephone service of the Post Office, realise the wonderful strides which have been made during the past few years in what is known as trunk telephony, or the application of the telephone art to such long distances as separate some of our larger centres of population. To render the service as immune from storm and other external influences as possible, the Post Office some years ago adopted a policy of placing its principal trunk telephone routes underground, and already many thousands of pounds worth of copper lie buried alongside some of the main routes connecting London with the Midlands and the North, including Scotland. The substitution of insulated cable for bare aerial conductors introduces technical difficulties in the matter of electrostatic capacity and inductance, which limit the distance over which telephonic speech can be efficiently transmitted through cable.

Following on this policy came numerous experiments in what was known as the artificial loading of cables to neutralise the natural characteristics of underground insulated conductors, when suddenly the thermionic valve amplifier, introduced just prior to the war, and developed amazingly during the conflict, materially altered all accepted standards, and opened up vast and astonishing possibilities, which are only just on the verge of realisation. The interesting tale of trunk telephone development is attractively told by Sir William Noble, the present engineer-in-chief to the Post Office, in a paper before the Institution, and we hope to reproduce this paper in our columns very shortly.

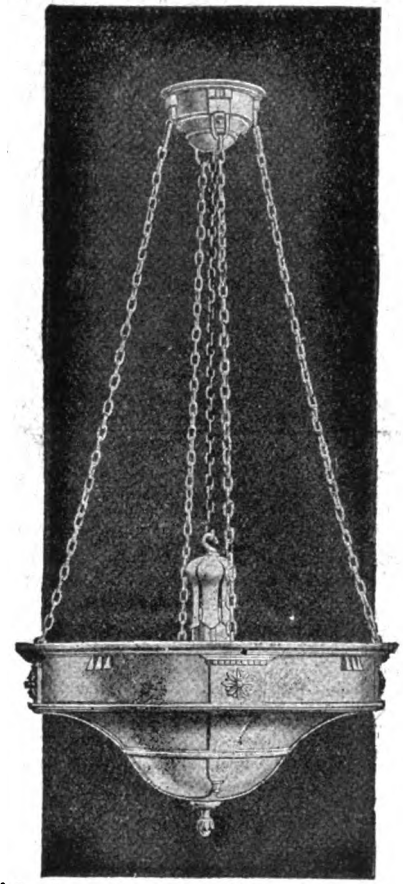
ELEKTRON.

EDISWAN DINNER.

A dinner was held at the Connaught Rooms on the 8th inst., at which the executive, management and depôt superintendents of the Edison Swan Electric Co., Ltd., were present. The chair was taken by C. Jermyn Ford, Esq. (chairman of the company), supported by Major Eustace Quilter and Mr. E. A. Gimingham (directors), and amongst the visitors were Messrs. R. C. Lanphier (vice-president of the Sangamo Electric Co., U.S.A.) and S. B. Rogers (European manager). The Sangamo Co., it will be remembered, is closely associated with the Edison Swan Co., which is the sole Sangamo agent for Great Britain and the Colonies. After the loyal toast had been duly honoured, the toast of "The Chairman" was proposed by the commercial manager, Mr. C. Horace Cox. "The Depôt Superintendents" was then proposed by Mr. J. W. Elliott (joint sales manager), and this was replied to by Mr. J. Taylor (Glasgow) and Mr. A. McDonald (Dublin). "The Visitors," proposed by Mr. E. A. Gimingham (director), was duly honoured, and was responded to both by Mr. Lanphier and Mr. Rogers. A musical programme was provided by the Misses Violet Holt and Barbara Laughton, Messrs. George Tinney, A. P. Ambler and E. H. Miller, the latter making a great hit with an Ediswan topical song.

INDIRECT LIGHTING.

A new catalogue of "Eye-Rest" fittings recently issued by the British Thomson-Houston Co., Ltd., illustrates a charming variety of designs, in both metal and moulded composition, and in a range of sizes to take Mazda lamps from 60 watts (vacuum) to 500 watts (gas-filled). All these fittings are equipped with X-ray silvered glass reflectors, the use of which accounts for the high efficiency of this system of indirect lighting, which has been installed in picture galleries, offices, public halls, stores, theatres, kinemas, private houses, etc. The invisibility of the light sources,



coupled with the soft and uniform diffusion of the illumination, produce an atmosphere of restful comfort and repose, and at the same time the most is made of the decorations on ceilings and walls, while architectural and decorative details, ornamentation, mouldings, furniture, etc., appear practically as if seen in diffused daylight. Indirect lighting is especially valuable for the illumination of art galleries and private rooms containing paintings, statuary and other articles of vertu.

The illustration shows one type of fitting, the "Imperia," of which the standard finish is matt white.

Readers desiring copies of the new "Eye-Rest" catalogue (No. 10,550—B.) should apply to the British Thomson-Houston Co., Ltd., 77, Upper Thames St., E.C.4.

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NEON ARC LAMPS.

A recent issue of the *Zeitschrift für technische Physik* describes neon arc lamps manufactured by the Studien-Gesellschaft für elektrische Lecchtröhren m.b.H.

Each lamp consists of a glass tube filled with neon at low pressure, and provided with two or more electrodes. The cathode consists of an alloy of the alkali metals and other metals. The alloy is solid, even when the lamp is running. The lamp is designed for use with direct current at 220 volts; the current required is about 1 amp., a suitable resistance being introduced in the circuit. In order to strike the arc a vacuum interrupter is connected in parallel with the lamp, a small choking coil being inserted in the common portion of the circuit. An inductive impulse set up by the automatic action of the interrupter by means of a magnetic coil, causes a discharge through the lamp. The colour of the light given out by the lamp is red, and is therefore specially suitable for advertising, signalling, and medicinal purposes. The lamp uses about ½ watt per candle-power, and has the great advantage over other vapour lamps that it can be lit and put out very quickly (as often as 400 times a minute).—(*Technical Review*).

ELEMENTARY DETERMINANTS

WITH SPECIAL REFERENCE TO KIRCHHOFF'S LAWS.

BY H. P. FEW.

Silver Medallist in Telegraphy, etc.

EIGHTH ARTICLE.

NOTE.—The aim of these articles is to bring out prominently the advantages of employing Determinants, in conjunction with Kirchhoff's Laws, for finding current values in complicated networks of conductors. The previous articles appeared in our issues of June 25, August 6 and 27, September 17, October 22, December 3, 1920, and February 25, 1921, and gave an account, *inter alia*, of Kirchhoff's Laws and corollaries, Maxwell's cyclic equations, general methods of evaluating determinants, application of determinants to finding current values in simple networks, including the Wheatstone bridge or net. This article deals with the Thomson double bridge.

In an earlier article we stated that the Wheatstone bridge is unsuitable for the measurement of low resistances. This is especially the case with the Post Office series-plug type of instrument, in which the numerous connections might possibly introduce errors approaching in the aggregate the value of the resistance under measurement. These errors are avoided in the Thomson (or Kelvin) double bridge.

The Thomson double bridge is shown diagramatically in Fig. 18; q is a standard low resistance and p is the

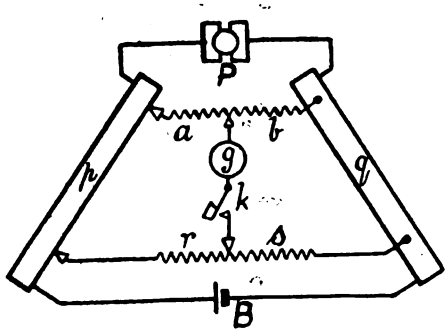


FIG. 18.

low resistance to be measured. The adjacent ends of p and q are connected together by a stout copper conductor and plug P; a b and r s are two resistances large in comparison with p and q connected between the extremities of p and q as shown. A galvanometer g in circuit with a key k can be connected at any point in a b and c d by means of sliding contacts. The test is carried out as follows:—The plug P is inserted, and the contacts of the galvanometer circuit are adjusted until there is no deflection when the key is closed. The plug P is removed, and generally the needle will now show a small deflection; the sliding contacts are again adjusted until the bridge is balanced. Then the following relation holds:—

$$\frac{p}{q} = \frac{r}{s} = \frac{a}{b}$$

Note that when P is open the arrangement forms an ordinary Wheatstone bridge.

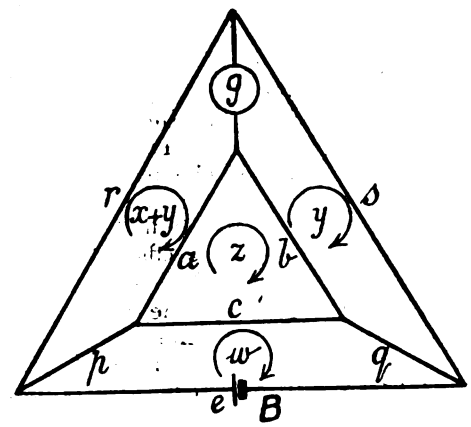


FIG. 19.

Fig. 19 shows the connections of the Thomson bridge in symmetrical form. It will be seen that the conductors can be regarded as tracing the edges of a truncated regular tetrahedron. The conductors have been lettered to agree with Fig. 18. Let the cyclic currents $x+y$, y, z and w flow as indicated, then forming our equations for the four meshes, we have—

$$\begin{aligned}
(B+c+p+q)\,w - p\,(x+y) - qy - cz &= e.\\
(a+g+p+r)\,(x+y) - gy - pw - az &= o.\\
(b+g+q+s)\,y - g\,(x+y) - qw - bz &= o.\\
(a+b+c)\,z - a\,(x+y) - by - cw &= o.
\end{aligned}$$

Rearranging—

$$\begin{aligned}
-px - (p+q)\,y - cz + (B+c+p+q)\,w &= e.\\
(a+g+p+r)\,x + (a+p+r)\,y - az - pw &= o.\\
-gx + (b+q+s)\,y - bz - qw &= o.\\
-ax - (a+b)\,y + (a+b+c)\,z - cw &= o.
\end{aligned}$$

Let us find the current x flowing through the galvanometer. Forming the determinant for x, we have—

$$x = \frac{\begin{vmatrix} e & -(p+q) & -c & (B+c+p+q) \\ o & (a+p+r) & -a & -p \\ o & (b+q+s) & -b & -q \\ o & -(a+b) & (a+b+c) & -c \end{vmatrix}}{\Delta}$$

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Where Δ is a determinant with the value of which we are not concerned. The expression then reduces to—

$$x = \frac{e}{\Delta}\begin{vmatrix} (a+p+r) & -a & -p \\ (b+q+s) & -b & -q \\ -(a+b) & (a+b+c) & -c \end{vmatrix}$$

Adding the second column to the first to form a new first column, we have

$$x = \frac{e}{\Delta}\begin{vmatrix} (p+r) & -a & -p \\ (q+s) & -b & -q \\ c & (a+b+c) & -c \end{vmatrix}$$

Adding column three to column one to form a new first column, we have

$$x = \frac{e}{\Delta}\begin{vmatrix} r & -a & -p \\ s & -b & -q \\ o & (a+b+c) & -c \end{vmatrix}$$

Expressing this as two second-order determinants—

$$x = \frac{e}{\Delta}\left\{r\begin{vmatrix} -b & -q \\ (a+b+c) & -c \end{vmatrix} - s\begin{vmatrix} -a & -p \\ (a+b+c) & -c \end{vmatrix}\right\}$$

Cross-multiplying—

$$x = \frac{e}{\Delta}\left\{r\left[bc+q(a+b+c)\right] - s\left[ac+p(a+b+c)\right]\right\}$$

$$= \frac{e}{\Delta}\left\{(qr-ps)(a+b+c)+c(br-as)\right\}$$

When no current flows through the galvanometer circuit, x is zero, and for this to be the case $qr = ps$ and $br = as$ simultaneously; Hence, when the double-bridge is in adjustment the double relation

$$\frac{p}{q} = \frac{r}{s} = \frac{a}{b}$$

holds good.

The principal advantage of the Thomson double bridge is that since the resistances a, b, r and s are large compared with p and q, errors due to the resistance of leads and joints is negligible.

(To be continued.)

SUPPLY OF ELECTRICAL POWER TO INDUSTRIAL WORKS,

WITH SPECIAL REFERENCE TO THE DESIGN OF SUB-STATIONS.*

BY A. P. ROBERTSON, A.M.I.E E.

(Continued from page 161.)

Another design of sub-station, Fig. 5, is shown where it is not feasible to build a high transformer house. In this station all the apparatus is arranged on one floor and the transformer is placed on beams over a pit. When it is necessary to inspect the transformer, it is raised by a block and the beams taken away, when the whole transformer can be lowered into the pit. The beams are made removable for this purpose. The core can then be lifted out of the tank and examined.

This is a type of sub-station suitable for small powers, and the L.T.A.C. switchboard is replaced by a cubicle containing an oil switch and transformers for metering. The meters are mounted in front, and the whole apparatus is thus totally enclosed. The outgoing leads are taken to a switchboard or fuses for distribution.

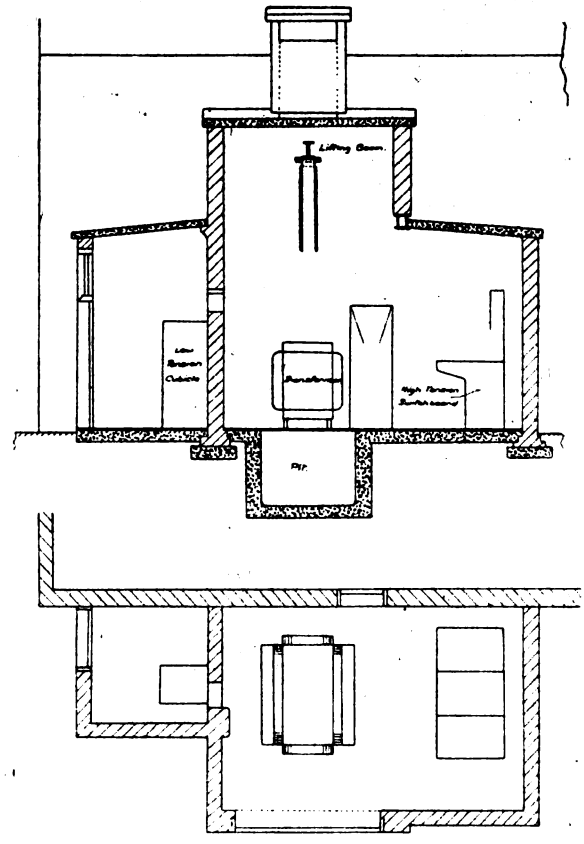


FIG. 5.

The cubicle can be built into the wall of the transformer house, and the front only shows on the wall face. This is a good arrangement, as the switch can be operated from another compartment, and the H.T. compartment totally isolated from any unauthorised person.

The standard for small wiring is preserved in these cubicles, and the wiring is fixed inside the front plate of the cubicle. The frame is of angle iron and the sides of sheet steel. They do not require much fixing, and are only held on to the floor by two ½-in. bolts.

Static sub-stations, or those containing transformers only and no moving machinery, do not require constant attendance, but they should be inspected at least once a fortnight and all switches dusted down and the gear examined. The meters and tripping battery should be looked to at the same time and any stoppage or fault attended to immediately.

As these sub-stations are connected on a main H.T. ring, it is essential that no unauthorised person should have access to the H.T. switches, and for this reason the H.T. gear, including the transformer, is placed in a separate compartment from the L.T. gear and the keys kept by the supply authority.

The lighting of static sub-stations is an item which is apt to be overlooked, but it should be good both in the switch-room and in the transformer house. Where there is a D.C. supply available, this should be used for lighting. Light is then available for cleaning and repairing when the A.C. plant is off. For sub-stations where D.C. is not available, a portable battery and lamp is a great convenience, otherwise candles or paraffin lamps are the only other alternatives for night work.

The transformers for these static sub-stations should be in standard sizes and the nearest size used to give a supply

*Paper read to the Royal Technical College Scientific Society, Glasgow, December 4, 1920.—Reprinted from *The Channel*, January, 1921.

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of the required amount. Above 700 k.w. it is a good policy to instal two transformers, as the larger transformers are heavy and difficult to handle. A three-phase transformer of 675 K.V.A. capacity weighs about 7 tons, and is heavy enough to handle in bad positions. There is also the added convenience that, if one breaks down, half the works can kept going while the faulty one is removed and another installed. In some special cases duplicate transformers are installed, although one is sufficient to provide all the power necessary—for example, in a cold storage where thousands of pounds may be lost by a stoppage of the plant. When the sizes of the transformers are larger, it is necessary to have three single-phase units connected to form a three-phase unit, as is done in certain of the step-up sub-stations where each of these single-phase units is rated at 1,875 K.V.A. 20,000 to 3,820 volts, and weighs about 18 tons.

An endeavour has been made to give an idea of the essential principles in the design of sub-stations without closely specifying the details of the plant whch should be left to specialists, and to point out what is necessary and what should be avoided, so that different designs and projects may be considered.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column

QUESTION No. 113.

I have received advice to fit magnetic clutches in my machine shop instead of the fast and loose pulleys so necessary for machine operation. Can any reader tell me how these are operated, and what type of clutches I shall require? My lighting voltage is 230 volts.—"PLANER."

QUESTION No. 114.

What are the advantages of shunt motors over series motors for lift operation, or *vice versa?* I am fitting shunt motors to some lifts in the works where I am employed, these being already on hand. Can any reader give me some practical hints concerning operation, controllers, limit gear, etc.?—"FLOOR."

(Replies to Questions Nos. 113 and 114 must be received not later than March 26, 1921.)

REPLIES TO QUESTION No. 109.

Two second prizes have been awarded this week to "M.M." and "Frequency." These competitors will, therefore, receive five shillings each.

The first step is to find the resistance of each step of the starter that will limit the starting current to a predetermined amount, generally 150 per cent., and sometimes 200 per cent., of the normal full load current.

Assuming an efficiency of 90 per cent.,

$$\text{the electrical input} = \left(\frac{100 \times 40 \times 746}{90}\right) \text{ watts,}$$

$$\text{and normal full load current} = \frac{100 \times 40 \times 746}{90 \times 440} \text{ amps.}$$

$$= 75 \text{ amps approx.}$$

Assume a maximum current of 150 per cent. normal $= \left(\frac{150}{100} \times 75\right)$ amps. and assuming an armature resis. of ·5 ohms.

The total resistance of the armature and starting resistance must be R, given by $\left(\frac{150}{100} \times 75\right) = \frac{440}{R}$

$\therefore R = 3{\cdot}9$ ohms approx.

As the machine begins to speed up, a back E.M.F. "e" will be generated, given by

$$\therefore 75 = \frac{440 - e_1}{3{\cdot}9} \quad \therefore e_1 = 147{\cdot}5 \text{ volts.}$$

On the 2nd step of the starter, the total resis. in circuit given by R_1 is found from

$$\left(\frac{150 \times 75}{100}\right) = \frac{440 - 147{\cdot}5}{R_1} \quad \therefore R_1 = 2{\cdot}6 \text{ ohms.}$$

And back E.M.F. "e_2" given by

$$75 = \frac{440 - e_2}{2{\cdot}6} \quad \therefore e_2 = 245 \text{ volts.}$$

On the 3rd step of starter total resis. R_2 is found from

$$\left(\frac{150 \times 75}{100}\right) = \frac{440 - 245}{R_2} \quad \therefore R_2 = 1{\cdot}73 \text{ ohms.}$$

And back E.M.F. "e_3" given by

$$75 = \frac{440 - e_3}{1{\cdot}73} \quad \therefore e_3 = 312 \text{ volts.}$$

On the 4th step of starter total resis. R_3 is found from

$$\left(\frac{150 \times 75}{100}\right) = \frac{440 - 312}{R_3} \quad \therefore R_3 = 1{\cdot}1 \text{ ohms.}$$

And back E.M.F. "e_4" given by

$$75 = \frac{440 - e_4}{1{\cdot}1} \quad \therefore e_4 = 357{\cdot}5.$$

On the 5th step of starter total resis. R_4 is found from

$$\left(\frac{150 \times 75}{100}\right) = \frac{440 - 357{\cdot}5}{R_4} \quad \therefore R_4 = {\cdot}73 \text{ ohms.}$$

Further calculation would produce R_5 = less than ·5 ohms, i.e., the resis. of the armature. Formulæ can be found in text books for quickly obtaining the number and the resistance of steps, but it is more helpful to have the steps worked out as above.

Tabulating we get—

Step.	Total Resis.	Resis. of step which = Total resis. − resis. of (last step + arm.)
5	$R_4 = {\cdot}73$ ohm	$r_4 = {\cdot}73 - {\cdot}5 = {\cdot}23$ ohms
4	$R_3 = 1{\cdot}1$ ohm	$r_3 = 1{\cdot}1 - {\cdot}73 = {\cdot}37$ ohms
3	$R_2 = 1{\cdot}73$ ohm	$r_2 = 1{\cdot}73 - 1{\cdot}1 = {\cdot}63$ ohms
2	$R_1 = 2{\cdot}6$ ohm	$r_1 = 2{\cdot}6 - 1{\cdot}73 = {\cdot}87$ ohms
1	$R = 3{\cdot}9$ ohm	$r = 3{\cdot}9 - 2{\cdot}6 = 1{\cdot}3$ ohms

It may be possible that this size of starter may have a further starting step to prevent the full value of the maximum current being switched on to the motor on the first step. This can be readily calculated depending on the permissible current on the first step.

Having determined the ohmic values of the steps, it

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is necessary to now determine the sectional area of the resistance material and the length. Assume a 30 seconds period for starting.

The sectional area a is given by the formulæ—

$$a = \sqrt{\frac{\cdot 24\, C^2 t \times \phi}{y\psi\,(T_1 - T_2)}}$$

where a = area in square min.
c = current (average).
t = starting period.
ϕ = specific resis. of material.
y = specific weight.
ψ = specific heat.
$(T_1 - T_2)$ = temp. rise which can be taken as 200° c. for a safe limit.

If we propose to use iron wire, average values are

$Y = 7{\cdot}7$, $\phi = {\cdot}1042$, $\psi = {\cdot}113$, and $\frac{\cdot 24\,\phi}{Y\psi} = {\cdot}028$.

$$\therefore\ a = \sqrt{\frac{{\cdot}028 \times 75 \times 75 \times 30}{200}} = 4{\cdot}875 \text{ sq. mm.}$$

which would correspond to a 12 gauge wire.

The length of wire required for each step can be found from the formulæ—resis. of step $= \frac{l \times (\phi = {\cdot}1042)}{(a = 4{\cdot}875)}$

"FREQUENCY."

To grade the starting resistance satisfactorily, it should be divided so that the ohmic values of the several divisions are in a geometrical progression. The number of contact studs are not given in the question. Suppose there are 21 studs; then the resistance will be divided into 20 parts. If we allow for 40 amperes when contact lever is on the first stud, the total resistance of armature and resistance will $= \frac{440}{40} = 11$ ohms. The resistance of the armature will be something like ·2 ohm. If the resistance of the armature is not known it can be found by "bridge" or by amperemeter and millivoltmeter.

The ratio of the progression may be found from: (armature res.) r^n = (res. of armature + starter)
where r = ratio
and n = number of divisions of the resistance.

$$\therefore\ {\cdot}2\, r^n = 11$$

$$r = \sqrt[20]{55}$$

$$= 1{\cdot}2218$$

Armature		= ·2 ohm
1st division	= (·2 × 1·2218) − ·2	= ·04436
2nd division	= ·4436 × 1·2218	= ·0542
3rd division	= ·0542 × 1·2218	= ·0662
.....		
20th division		= 1·9857
	Total	11 ohms

With a larger number of divisions in the resistance, acceleration would be slower and *vice versa*.

Above has been taken as a fair average, but each starter should be considered in connection with the work it actually has to perform. It will be recognised that some loads have much more inertia than others and require more liberally designed starters.

The first 17 divisions (counting from armature) to be of No. 8, the other three of No. 10 Eureka wire.

"M. M."

THE OSRAM G.E.C. LAMP WORKS.

At the invitation of the General Electric Co., Ltd., on Friday last, the Institution of Municipal and County Engineers and representatives of the Press paid a visit to the spacious modern Osram factory at Hammersmith. This factory now gives employment to over 3,000 workers, and contains some of the most ingenious automatic machinery in the world. It has grown steadily to its present size and importance since 1908, when the patent rights for the manufacture in Great Britain of Osram lamps were acquired. The factory for their manufacture was erected adjoining the "Robertson" Lamp Works (started in 1893 for the manufacture of carbon filament lamps) and was the first large factory in this country for the production of metal filament lamps. A visit to the factory to-day reveals the fact that it is independent of outside aid, as will be appreciated from the following brief description of the manufacturing processes:—

The filament is prepared from pure tungsten, obtained from ore mined in the British Dominions overseas. In the form of powder it is compressed by powerful hydraulic presses into rectangular bars, which, by a series of interesting processes, are gradually hammered and drawn into a wire of extreme fineness varying, of course, according to the size and voltage of lamp for which it is intended. The wire is then wound upon bobbins and stored for use as required.

To support the filament the stem or "spider" is formed from glass tube and rod cut into suitable lengths. Short lengths of tube are flanged at one end by a machine fed from hoppers, and the solid glass centre rods are cut and shaped by blow-pipe, studs being formed to carry the filament supports. The leading-in wires are built up of copper, platinum and nickel, and in the next stage flanged tube, centre rod and leading-in wires are fused together and hermetically sealed.

The actual wires that support the filament are of nickel, cut and looped ingeniously by a machine, and when these have been inserted the "spider" is ready for the winding on of the filament of tungsten, a delicate process done by hand; it is then "set" by flashing in an atmosphere of hydrogen, diluted with nitrogen to prevent explosion. The complete foot carrying the filament is now inserted in the bulb, which has previously been provided with a glass exhausting stem, sealed in position by the blow-pipe, but to be removed later. The glass is made and the bulbs blown at the company's Lemington-on-Tyne Glassworks. Next the bulbs are exhausted six or eight at a time and rapidly tested. The girls who carry out this process sit on trolley seats that run on rails, smoothly and easily, and are thus able to pass quickly up and down from one set of lamps to another, and to supervise several groups with very little trouble. The lamps are then sealed off, the only trace of the exhausting stem left being the familiar "pip."

Samples from each batch of lamps are put through life tests extending to many hundreds of hours, and on the "ageing racks" where the lamps are constantly burning, inspection continually goes on; should any fault betray itself during this prolonged trial, the lamp is immediately scrapped. Every lamp at this stage goes to the photo-metric department, where it is tested

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and graded. After this comes the placing on of the cap and the soldering of the leading-in wires. The caps, received from the Birmingham works of the company, require the insertion of contact-pieces, which are fixed in position by a special insulating material of a glass-like nature known as "vitrite." This operation is carried out on automatic machines. After a final test has been made comes branding, a last clean-up and packing ready for despatch.

The gasfilled lamp is made in a very similar manner, speaking generally, but a few additional processes are necessary. The filaments, for instance, are "spiralised" by winding the tungsten wire into finely coiled helices on suitable mandrels running at high speed, great care being necessary to ensure the correct spacing between the turns. After the bulbs are exhausted of air, they are filled with the necessary inert gas, which may be either argon or nitrogen, according to the type of lamp; nitrogen being used only for heavy current lamps. The argon used is obtained by a liquid air plant at the factory, the process being known as direct fractionation.

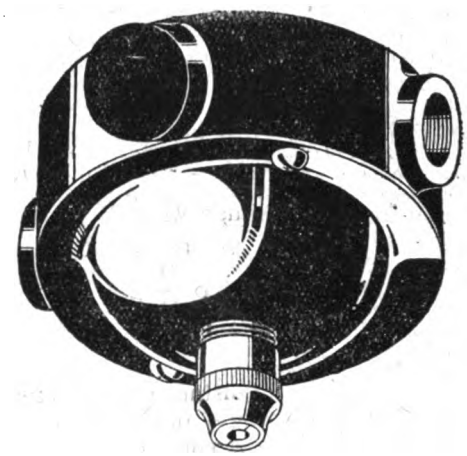
The automatic machinery, much of it designed on the premises, never fails to attract attention on account of its ingenuity, but even more wonderful is the process of blowing bulbs by machinery at the G.E.C. Lemington-on-Tyne Glassworks. Here there is no intervention of human hands between the red hot molten glass and the perfect bulb, and one attendant can supervise the production of thousands of bulbs in a day. Modern gas-fired furnaces, the temperature of which is controlled by electrical pyrometers, are installed—the works producing their own gas—and every appliance, every invention or application of science that tends to increased production and efficiency of manufacture, is adopted.

Reference should also be made to the finely equipped and excellently staffed research laboratories of the G.E.C. at Hammersmith, as well as to the fact that further extensions to the Osram Lamp Works on a very large scale are in contemplation, some of which are on the verge of completion, with the aim of not only meeting the requirements of this country, but of filling the enormous overseas demand.

At the conclusion of the inspection the whole party adjourned to the Clarendon Hotel when Mr. C. Wilson presided at an excellent luncheon. He was ably supported by Mr. Fletcher (a co-director), Mr. Driver, Major Palmer, Mr. Heather and other members of the G.E.C. organisation. The toasts included "The Institution of Municipal and County Engineers," proposed by Mr. Wilson and replied to by Mr. T. W. A. Hayward, Borough Engineer of Battersea; "The G.E.C.," proposed by Mr. Norman Scrogie, Borough Engineer of Hackney, and well answered by Mr. Fletcher, who said they aimed at making the factory the leading one of its kind in the world; and "The Press," of which Councillor Charles Pascall made very flattering remarks, and on whose behalf our old friend Mr. Chambers-Smith (editor of *Municipal Engineering*) gave due thanks in an excellent speech. Then Mr. Scorgie proposed "The Chairman," who was harmoniously told "he's a jolly good fellow," and Mr. Wilson said he appreciated the kindly remarks, after which he vacated the chair for the continuance of a discussion by the members of the Institution. Altogether a very pleasant function arranged with that care and forethought which one always associates with Major Palmer and the G.E.C. publicity department.

A NEAT CORD GRIP PENDANT BOX FOR CONDUIT WIRING.

The illustration shows the latest pattern cord grip pendant box, for use with screwed conduits, as made by the Metallic Electrical Engineering Company, of Meta House, Corporation Street, Birmingham. The box itself is of malleable iron, tapped four ways, and



a neat dome cover of steel bronze, held in position by two screws, is provided. Thus, a ceiling rose is unnecessary, and economy in wiring costs, combined with neatness, is thereby secured. The complete box, which is a War Office pattern, is strongly made, and most suitable for use in ships, schools, churches, public buildings, etc.

A leaflet giving the reduced prices now in force of Osram miner's hand lamp pattern bulbs with bow filaments is being circulated by the **G.E.C.** The leaflet also refers, briefly, to the "Kingsway" miner's electric hand lamp. The bulbs comply with H.M. Home Office Regulations applying to miners' hand lamps and give a minimum illumination of 1 British c.p. at the rated voltage. The filament has been designed to give uniform brilliance over its whole length and to have great mechanical strength.

We have received from the **Henry Wells Oil Company,** 11, Haymarket, London, S.W.1., a copy of an interesting brochure entitled "The Germ Process in a Nutshell." In this booklet the remarkable results obtained by this radical innovation in the practice of lubrication are set forth in novel and most convincing manner. It is claimed that "germ process" lubricating oils have about 26 per cent. higher lubricating efficiency than mineral oil of the same viscosity, also this efficiency is maintained much longer. In other words, a thin "germ" oil does the same or better work than a 15 per cent. thicker plain mineral oil and effects a corresponding saving in lubrication costs. Some of the many uses of "germ process" oils are noted in this publication, which, together with other literature on the subject, will be sent gratis by the firm to all oil users. The new process is one of first-class importance to all users of machinery, and the Henry Wells Oil Co. are at all times willing to give advice and information on the subject. In conclusion, it may be mentioned that the "germ process" is entirely British.

Meetings.—The Junior Institution of Engineers will meet u Friday 1st April, at 39, Victoria St., Lecturette, "Pneumatic Conveyors," by Mark Jennings (Member), at 7.30 p.m. Also on Tuesday, 5th April, Visit to the Works of the Tunnel Portland Cement Co., Grays, Essex. The party will assemble in the booking office of Grays Station at 2.50. And on Friday, 8th April, at Caxton Hall, at 8 p.m., Questions and General Discussion.

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Various Items.

Accrington.—The T.C. have granted free passes to all ex-Service men resident in Accrington who are unable to move about without artificial assistance.

Removal.—On and after April 4, 1921, the registered office of the General Electric Company, Ltd., will be situated at Magnet House, Kingsway, London, W.C.2.

City and Guilds' Final.—Readers who are interested in the C. & G. exams. will be pleased to hear that we have arranged to publish the Solutions to the Final Papers in Electrical Engineering which are to be set in the forthcoming exams., and they will appear in our columns in due course.

Freemasonry.—The Secretary of the Kelvin Lodge wishes to remind the members that owing to the Easter holidays the next regular meeting will be held on Thursday, March 31, and not on Friday, March 25 (Good Friday), and trusts that they will turn up in good force on that date.

H. Pratt, Ltd., heating and ventilating engineers, of High Street, Aston, Birmingham, have opened an electrical department in connection with the installation of electric lighting and power plants and the sale of electrical plant and accessories. The company will be pleased to receive catalogues and prices from manufacturers desirous of entering into business relations.

Dowlais—Cardiff Colliery.—The B.T.-H. Co., Ltd., have installed a new mixed steam turbo air compressor, considered to be one of the largest, if not the largest, of its kind in the United Kingdom. The turbine is of the impulse type, developing 2,300 to 2,400 horse-power and a speed of 3,000 revolutions per minute. The compressor is of the B.T.-H. rotary type, with a capacity of 14,000 cubic feet of air per minute.

"Of Very Great Use."—That is what a well-known electrical engineer has just written about "The Practical Electrician's Pocket Book." It is a pleasing testimonial, and as it was quite voluntary on the part of the writer, it is all the more gratifying. Any reader who has not yet purchased his copy of the 1921 edition should do so promptly, because the stock is rapidly running out. From bookstalls and booksellers everywhere. Remember the title.

An Experiment at Newport.—The Harbour Board have had submitted to them plans prepared by the Borough Electrical Engineer for the establishment of a single unit pumping station for the purpose of making investigations to demonstrate the use of river water for condenser cooling purposes as a practical proposition or otherwise. The Works Committee recommended the Board to approve the scheme, subject to the Corporation giving an undertaking to relieve the Board of all liability arising from accident.

Marconi Station for Switzerland.—The Marconi Co. has been authorised by the Swiss Government to construct a wireless telegraph station for operation over a period of 25 years by a Swiss company. The station is to be erected near Berne, about 1,500 feet above sea level, and a Marconi valve continuous wave transmitter of 25 kw. capacity will be used. the aerial being carried on two towers 300 ft. high. Up-to-date apparatus for high speed automatic working will be installed for commercial and Press work.

Clyde Valley E.P. Company.—In common with most of the big power companies this company's balance sheet and statement of accounts for the past year makes satisfactory showing all round. A final dividend of 10 per cent. per annum on the ordinary share capital, making 7½ per cent. for the year, is recommended. The 15,000 kw. turbo-alternator, installed at Yoker Power Station, has been running since March last year on commercial load, but the installation of the 15,000 kw. turbo-alternator at Clyde's Mill Power Station has been considerably delayed, but it is expected that the plant will be in operation in June.

Meetings.—The Inst. E.E. will meet on Thursday, April 7, at the Inst. C.E., Great George Street, Westminster, S.W.1., at 6 p.m. Paper: "Some Recent Developments in Steam Turbine Practice," by K. Baumann.—A general meeting of the Institution of Production Engineers will be held on Saturday April 2, at 5 p.m., at 2 and 4, Tudor Street, London, E.C.4., when the Articles of Association and By-laws which have been drafted by the provisional committee will be submitted for the approval of the meeting. All interested, and particularly prospective members, are invited to attend and to signify their intention of being present to the Hon. Secretary, Mr. A. T. Davey, 6, St. James's Square, Holland Park, Kensington, W.11., in order that the necessary arrangements may be made.

Water Power and Industrial Development.—At a meeting of the Inst. of C.E. of Ireland, held at 35, Dawson Street, Dublin, on the 7th inst., Mr. Francis Bergin, president, in the chair, a paper on "Hydraulic Power for Industrial Development," by Mr. John Rochford, was read. The growing demand for the development of the industries in Ireland, the paper stated, required a means of supplying power at a cheap rate for factories, etc. The many loughs and rivers in Ireland were awaiting to give their powerful assistance to the industrial movement without payment, and it was possible to construct dams in various places for storing the excess water in winter and during non-working hours. Should a steel pipe be brought from the Roundwood Reservoir to Dublin the pressure would be 180 lb per sq. in. Even at the present time power could be obtained from the water flowing into the city. The overflow at the by-wash pier during the winter months could also be utilised for electric lighting and factories. By taking advantage of that supply and other suitable loughs and dams the city rates could be reduced, the tram fares lowered, and industries encouraged. It only remained for the Government, the author said in conclusion, to develop its industries by utilising the extensive available water power, and thus cheapen production.

Trade Notes.

The Rodney Foundry Co., of 89, Larcom Street, Walworth Road, London, S.E.17, have just completed the addition of another bay to one of their foundries, and are prepared to quote special rates for machine-moulding repetition work. They claim that they can supply general engineers' castings of such quality at such prices as will compare favourably with any in the country.

Spauldings Ltd. (40, Gloucester Street, Clerkenwell, E.C.1), manufacturers of high-grade vulcanised fibre in sheets (hard and flexible), tubes, rods and in special shapes to meet all electrical requirements, have sent us a 4-page leaflet illustrating a number of their productions. They inform us that they supply cheaply, quickly, work to close limits, and guarantee a high and uniform grade of material.

The General Electric Co., Ltd. (67, Queen Victoria Street, E.C.4), have recently published a leaflet dealing with "Wilton —M.L." circuit breakers. These are compact breakers of the laminated brush type, with anxiliary metal contacts and carbon break. The main contact blocks on the switch arm are connected electrically by two metal strips which carry the main current. These strips operate two spring-mounted catch pieces which engage with a cylindrical catch. An overload causes sufficient expansion of the strips to release this cylindrical catch, thus operating the breaker. A time lag based on heating is thus inherent. No-voltage attachments can be fitted, and certain adjustments provided. The breakers are made in the "open," "ironclad factory," and "mining" types. Weights, prices, and dimensions are given.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
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APRIL 1, 1921.

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ELECTRIFICATION OF A DIAMOND CUTTING FACTORY.

Considerable attention has recently been drawn to the opportunities of profitable employment afforded to disabled soldiers by the introduction into this country of the diamond cutting industry, the schemes having been inaugurated by Sir Bernard Oppenheimer, who has had four factories built, using Belgian experts as original instructors. The three branch factories are intended as training centres from which the men will ultimately be drafted to the main works, which are at Brighton, where operations are carried out on a commercial basis, the men being enabled to earn a wage which, though not very large at first, soon compares favourably with that earned in other skilled trades.

The Brighton factory has been equipped throughout on modern lines, the buildings being commodious, light, and clean. It was recently inspected by H.R.H. the Prince of Wales. For the employees still in need of medical treatment a special surgery is available; treatment is given as required, with the minimum interference with the men's ordinary work. This medical treatment, where necessitated by war disabilities, is provided by an arrangement with the Ministry of Pensions. Electric power is used throughout for the various sawing, cutting and polishing machines, the workshops containing in all 105 motors with the necessary control gear. Both D.C. and A.C. power is brought in from the mains of the Brighton Corporation. The former is 460 volt 3-wire for lighting, and the latter is 6,600 volt 3-phase transformed down to 400 volts, and distributed to the motor circuits through a G.E.C. switchboard.

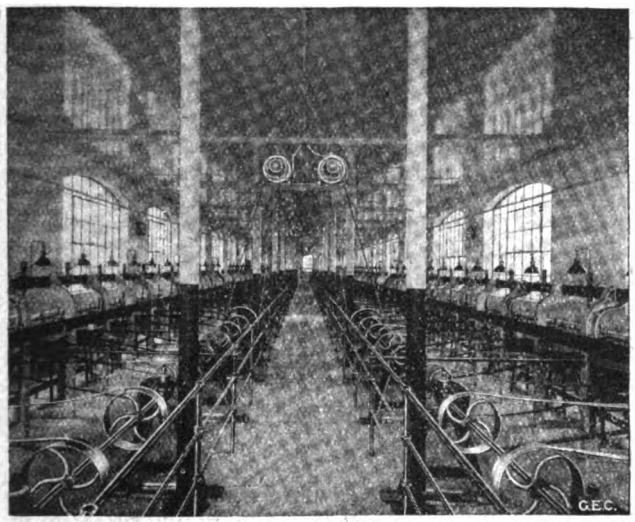


FIG. 1.—GENERAL VIEW OF POLISHING BAY WITH ROOF MOTORS.

The buildings are in two large three-storied blocks on opposite sides of the road, each forming three sides of a rectangle. By far the greater part of the space is taken up by bays similar to that shown in Fig. 1, each with about 100 polishing units. It will be more convenient, however, to consider the various workshops in such sequence that the processes of diamond cutting and polishing are dealt with in the order in which they are performed. The first step necessary on receipt of the uncut diamond is to mark it out; it is then sawn into suitable sizes. This is accomplished by means of saws; the diamond, during this process, is in a clamp which admits of the most delicate adjustment.

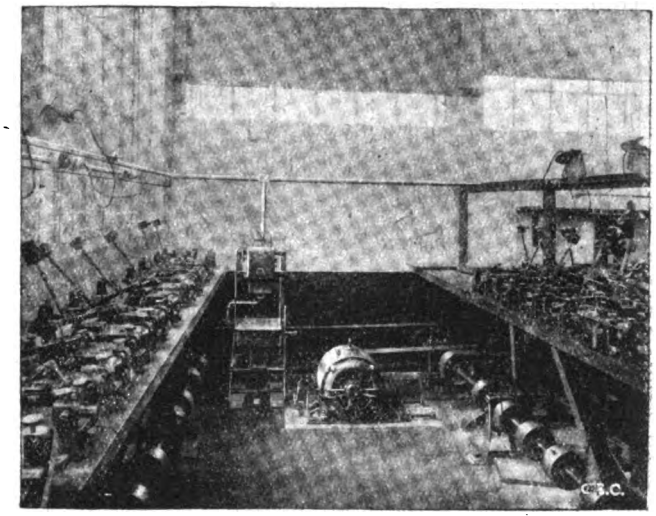


FIG. 2.—ONE OF TWO 10-H.P. MOTORS DRIVING SAWING MACHINERY.

The saws are driven from line shafts, two 10-h.p. squirrel cage motors, running at 960 r.p.m., being required in the room shown. In Fig. 2 one of these motors with auto-transformer starter is shown. It is interesting to note that the saw blades used are of phosphor bronze, 3/1000ths of an inch thick. They are trued up in centres, and on them is pressed diamond dust and olive-oil so as to produce the required degree of cutting power. Two of these saw-making sets are to be seen on the bench in Fig. 3, each driven by 1/10 h.p. motors at 2,000 r.p.m. The sawing-room contains in all six of these benches. When the diamonds have been sawn to suitable sizes for further treatment, they are cut. The cutting is really turning by hand on small lathes. One diamond is used as a tool to take corners and sharp edges off another, and the stone is thus brought roughly to the shape of the finished jewel.

The stone is next polished by pressure on a rotating disc. There are 1,500 of these polishing units installed. It may appear somewhat surprising that the space devoted to sawing and cutting is so modest, but it must be borne in mind that one man takes charge of as many as 20 stones at a time on the saws and that cutting is a very rapid process, whereas each individual facet (there are 58 on each stone) must be separately formed on the polishing discs.

The polishing bays are each equipped with six 7½ h.p. squirrel cage motors, each machine driving 17 discs at a speed of 2,400 r.p.m. In the four bays on the first floor of the two buildings the motors are on the floor, but in the

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bays on the top floor, the motors are suspended from the roof. Each motor in these bays, as throughout the installation, is controlled by an auto-transformer starter panel.

From the electrical point of view the chief interest lies in the extent to which the electric drive fits in with the main object kept in view in laying out the factory and its equipment—that is, the provision of simple, clean and efficient methods of carrying out the various processes involved.

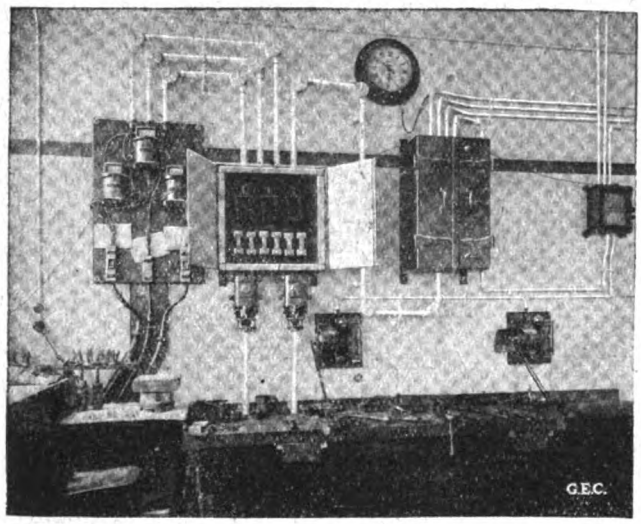


FIG. 3.—DISTRIBUTION BOXES IN SAWING-ROOM.

A word should also be said as to the lighting scheme, which, by a suitable combination of general and local units, enables a high degree of illumination to be concentrated upon any part of the work in hand. Each man has a unit consisting of Osram G.E.C. lamp and enamelled reflector with flexible lead, which is hung just above the bench when not in use. When the extreme accuracy required in polishing a small diamond is considered, it will at once be obvious how necessary is an efficient lighting system.

The whole of the electrical equipment for both power and lighting was supplied by the General Electric Co., Ltd., who obtained permission from Dr. Beckit Burnie, the General Manager of the factory, to take the photographs reproduced. He also kindly supplied much of the information given.

INDUSTRIAL APPLICATIONS OF X-RAYS.

In his third Cantor Lecture at the Royal Society of Arts on Monday, March 21, Major G. W. C. Kaye dealt with the practical application of X-rays to the testing of materials—a method which enabled the whole article to be tested without damage, detected concealed defects, and showed the accuracy of assembling of component parts. The development of industrial radiology had been bound up with that of the Coolidge tube, and both during and since the war X-rays had been applied to a variety of branches of industry. It should be made clear at the beginning that X-rays did not reveal the microscopic structure of the material. They only showed the gross structure of the material in the aggregate. The present practical application of X-rays to the investigation of materials had reached a point when it was possible to X-ray lead to a thickness of 4 or 5 mm., tin to the extent of 12 mm., carbon steel or iron to the extent of 7.5 cm., aluminium and its alloys 12 to 15 cm., and wood 20 to 40 cm. It was difficult, however, to lay down figures of penetration into materials precisely, because progress was so rapid that they might be doubled next week. The limiting factor was the length of exposure and voltage, and it was possible now, for example, to get a photograph through an inch of steel in rather less than a minute, using 130,000 volts with a few milliamperes through the Coolidge tube. Within the thicknesses he had mentioned it was possible with considerable accuracy to hunt out anything of a foreign nature in the material being investigated, and even to detect the finest tool marks and thin mould marks. Different densities in the materials displayed different densities in the radiographs. For example, a rivet would show darker than the material in which it was placed, whilst carbon, nickel and tungsten steels differed very little in transparency. This property of difference in densities had been made use of by storekeepers.

One promising outlet for the X-ray method of testing was in regard to welding. Electric and oxy-acetylene welding had come into great prominence during the war, and an indifferent welder could turn out large numbers of welds which appeared to be first class, but which in practice had nevertheless proved to be quite unreliable. There was no adequate mechanical test for a weld, and in any case such a test, whether mechanical or microscopical, destroyed the weld, good or bad. When an X-ray photograph was taken of a weld the presence of a shallow line indicated that the two parts were not truly joined together throughout the whole of the depth Blisters and blowholes showed up as light spots, and were the sign in many cases of overheating. The examination by X-ray photography of welds up to 1 in. in thickness was now quick, easy and certain, and with modern equipment lengths up to 2 ft. or more could be investigated at once, the exposures taking a fraction of a second. The amount of detail revealed in the photographs was extraordinarily good, and compared favourably with photo-metallography, which, however, only tested a tiny bit of the weld and involved its destruction. He hardly thought the X-ray method for testing welds had made the progress it deserved, perhaps because it was a somewhat severe critic of present-day welding. Again, X-ray investigation promised to be exceedingly useful for the detection of hidden cracks, which were the great bugbear of metallurgists. Such cracks were often the sequel to pipes or blowholes in the original ingot. In the case of alloys the uneven distribution of the component parts resulted in a streaky or patchy negative. X-ray examination would also often diagnose defective soldering or brazing, the substitution of one metal by another, hidden corrosion in gas cylinders, ferro-concrete and the armouring of cables, and so on. X-ray examination also proved very effective during the war in regard to explosives, particularly in relation to enemy ammunition, the exact composition of which we did not know, and before opening it up X-ray examination was resorted to with great success. Most of this work was carried out by the Research Dept. at the Royal Arsenal, Woolwich.

In the case of timber different varieties absorbed X-rays to different degrees. The peculiarities in the structure were shown in the negatives, it was easy to

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determine hard wood from soft wood, and the summer and winter growths of the annular rings showed up clearly. X-rays were turned to good account in this connection during the war in the examination of timber for aircraft at a time when the submarine was endangering the country's supplies of high-grate timber, such as spruce and Oregon pine. The result of this was that designs were got out for building up aeroplane parts from smaller timber, and in using smaller timber one of the first things to be certain about was the workmanship. In using smaller timber for struts and spars much of the workmanship was completely hidden from view, and it was impossible to ascertain the quality of it except by X-rays. Wood was very transparent to X-rays, and thicknesses up to 18 in. could be dealt with very rapidly. Another application was in examining the behaviour of the built-up structure whilst it was being tested, and it was possible to observe which parts collapsed first in the hidden structure as the material was put under test. Radiographs taken of built-up structures in this way threw an astonishing light on the behaviour of built-up aeroplane parts.

Other industrial applications of X-rays were in the manufacture of carbon and graphite brushes for electrical machinery, insulators, etc. Again, one of the gravest troubles encountered in the manufacture of optical glass was the destructive action on the molten glass of the fire-clay pot, and it was found that this was due to the presence of iron and other impurities in the clay of which the pots were made. It was possible, however, by X-ray records, to sort out the good pots from the bad ones, and so save considerable expense in spoiled glass. Another use to which radiography was put during the war was the examination of the electrically heated clothing of airmen in order to ascertain where the wiring had failed, whilst the examination of the distributors of magnetos, in order to avoid taking the apparatus to pieces, was yet another application.

The ideal aimed at in X-ray photography was to make it as easy and automatic as taking an ordinary photograph. The present limitations of the process in metallography were prescribed largely by technique and equipment, and large improvements would have to be made if it were to become a commercial proposition in heavy engineering. Adequate means would have to be found to reduce the length of exposure, whilst attention would also have to be paid to the production of heavier X-ray tubes and higher voltages, or more sensitive screens and plates. All experience tended towards demanding higher voltages. The Coolidge tube worked at 180,000 volts, preferably less, but the voltage could be increased to 300,000 by lengthening the arms of the tube and immersing the whole thing in oil. If there were a demand for it, no doubt the electrical engineer would overcome the difficulties of supplying 500,000 or more volts, as transformers had been made for such a voltage. A single-phase transformer, however, for 1,000,000 volts would have dimensions of 13 ft. by 9 ft. by 10 ft. high, the terminals would be 28 ft. high, the weight 20 tons, and the cost £10,000. Heavier currents would demand more elaborate cooling devices, and probably glass tubes would have to go. Silica tubes might be the alternative, or even metal tubes might be resorted to. Such tubes would probably be radically different in design, and attempts would have to be made to improve the deplorable efficiency of the whole apparatus. Again, great improvement in fluorescent and photographic plates were called for. No screen was available which would enable us to tackle more than a quarter of an inch of steel by visual examination; photography had to be resorted to, and the time taken might be prohibitive, at any rate for routine mass inspection. The photographic plate only registered about 1 per cent. of the X-rays passing through it, and progress had been in the direction of thickening the emulsion or loading it with more silver. Any X-ray plate was far more sensitive to visible light than it was to X-rays, but it should be possible by suitable improvements in fluorescent screens to pull down the exposure considerably. There were several developments in that direction already.

In conclusion, Major Kaye said the subject of industrial radiology was young, and although progress had been rapid, care must be taken not to claim too much for it. From such experience as there had been it could be said that the method had settled down to be a valuable laboratory tool to supplement other methods of testing materials, and the existence of the method had not been without a stimulating effect as regards the standard of workmanship in various directions. He, therefore, asked his audience for its moral and material support for the scheme of an Institute of Radiology in London.

Mr. A. A. Campbell Swinton, who presided, said it was almost exactly twenty-five years ago that he delivered a lecture on Röntgen's photography of the invisible at the Royal Society of Arts, the first occasion, he believed, upon which X-rays had been shown in this country to a public audience. With regard to the inefficiency of methods of producing X-rays at the present time, the only way in which these rays could be produced now was by causing cathode rays to impinge upon some solid body, and the inefficiency was terrible, because only 2 or 3 per cent. of the whole of the energy was turned into Röntgen rays, whilst the rest went into heat. That was not surprising, because the same thing applied to light, whether by electricity or gas; the nearer they got towards the violet end of the spectrum the worse was the efficiency. Therefore, it was only to be expected that when they tried to make Röntgen rays, which were analogous to extremely ultra-violet light, the efficiency should be very bad. A more efficient method of producing light was to use a gas and not a solid, as in the mercury arc lamp. Some years ago he had tried to make Röntgen rays by causing cathode streams to impinge upon each other. Of course, it was a stupid experiment, and in the light of present knowledge, was not in the least likely to produce any effect, but it had occurred to him—it might be a foolish suggestion, but he was going to make it all the same—as to whether better results would be obtained by causing a collision between a cathode stream of negatively electrified particles and a stream of positively charged particles, such as Sir J. J. Thomson used in his experiments upon positive rays. It was conceivable that they might get something analogous to what went on in the mercury arc lamp, and in that way get a higher efficiency than with ordinary methods.

South Africa.—Generating plant, steam driven, switchgear and cable is required by King William's Town. Particulars from the Boro' E.E., a deposit of £2 2s. being required. Tenders must be in by August 1.

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LONDON AND HOME COUNTIES' ELECTRICITY DISTRICT.

Details have now been issued of the engineering scheme proposed by the Conference of Local Authority Undertakers, the L.C.C. and nine electric supply companies (see also ELECTRICITY, February 11, p. 84). The Committee appointed considered two possible schemes :—(*a*) Shutting down all existing local stations and taking the supply from new Capital Power Stations erected on suitable sites; (*b*) Retaining and developing certain existing local stations, gradually shutting down the remainder and establishing new Capital Power Stations as required. (It is improbable that any Capital Station under the Joint Electricity Authority could be erected and fully ready to work earlier than the winter of 1925).

The following is a summarised account of the conclusions and recommendations reached :—Supply to be three-phase 50 cycles north of the Thames, and both 25 and 50 cycles south. Primary transmission pressure 33,000 volts, secondary 6,600 or 11,000 volts. Cables to be three-core, paper insulated, lead covered and armoured—generally laid direct in the ground. In special cases unarmoured cables to be drawn into ducts. Standard sizes 0.15 sq. in. and 0.25 sq. in. Overhead transmission in some outlying areas.

The arrangements as regards existing generating stations may be divided into two stages: (1) Thirty-four stations to be shut down progressively, and, by means of inter-connecting cables, to supply them in bulk from the remaining stations. At the same time certain Capital Stations would be erected, and, as these became ready for work the second stage would be reached, when 26 of the remaining stations would be progressively shut down. Of the remaining 17 stations existing in the area, two would be reconstructed and considerably enlarged to act as Capital Stations, and seven would be permanently retained to act as auxiliary generating stations in conjunction with the new Capital Stations. The other eight, near the outskirts of the area, would have to be kept at work for a considerable period to serve the local demands, until it became commercially possible to extend the transmission mains to their neighbourhood.

In addition to the two already referred to, four new Capital Stations would be erected on sites on the Thames, three on the north side of the river and one on the south. The installed capacities of the Capital Stations would vary, in the first instance, between 70,000 k.w. and 200,000 k.w., mostly in units of 25,000 k.w. Several of the sites would permit of much larger stations if required. The sites are not disclosed as they obviously cannot be purchased at once and premature disclosure might prejudice their purchase at a later date.

It is not proposed that any works should be constructed by the Minister of Transport, under Section 18 of the Electricity (Supply) Act, 1919.

It is proposed to leave the existing generating station (tramways) of the L.C.C. (Greenwich), and the existing generating stations (railways) of the Underground Rlys. (Lots Road), Met. Rly. (Neasden), G.W. Rly. (Park Royal), L. and S.W. Rly. (Wimbledon) and L. and N.W. Rly. (Stonebridge Park) to supply energy as heretofore to their respective systems. In most cases the plant at these stations is already fully loaded, and no good purpose could be served by incorporating it in the general system of supply; moreover, two of the stations, viz., Lots Road and Neasden, supply at 33⅓ cycles. In one or two cases, however, it is possible that arrangements might be made for additional plant to be erected in generating stations owned by railway companies, and for energy to be sold to the Joint Electricity Authority.

Any railway system in the area, not already electrified, would be able to obtain its supply of energy from the new Capital Stations, while additional supplies could be given from them to those railways already electrified.

In connection with the investigation by the Committee (Sir A. B. W. Kennedy, Mr. G. W. Partridge, Mr. J. H. Rider, Mr. C. H. Wordingham and Sir Philip Dawson) of present and future demands, the following conclusions on (1) load factor and (2) diversity factor were reached :—

(1) Load Factor.

The average annual load factor in the area ten years ago was 20.7 per cent., and in 1913-14 it was 21.5 per cent. During the war period it gradually rose to 25.4 per cent., and remained at this value both in 1917-18 and 1918-19, while in 1919-20 it dropped to 21.6 per cent. It will be seen, therefore, that the load factor has changed very little during the last ten years, except for the abnormal circumstances caused by the war, in spite of the fact that the industrial load, including heating, now takes up a much greater proportion of the total power than it did ten years ago. It is to be noted, on account of its possible bearing on the future, that during the last two years the maximum load has increased by 27,000 k.w., while the units sold have diminished by over 45 millions.

(2) Diversity Factor.

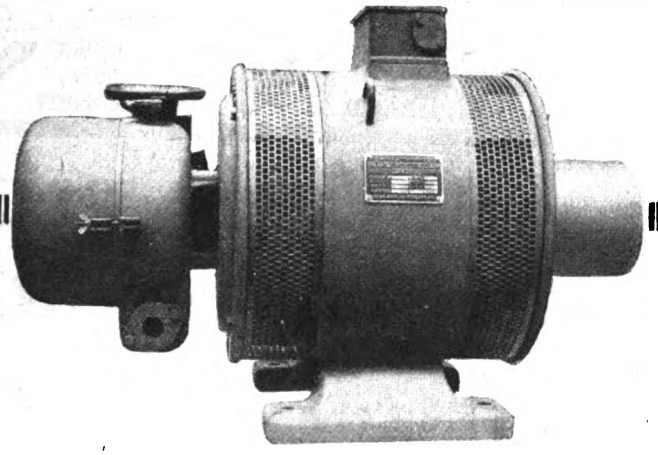
The effect of diversity factor has so often been alluded to that the Committee have made a detailed examination of what the possible diversity factor over the area of supply would be if all the principal undertakings were to be supplied from one single source. It is found that even in this case—an impracticable one—the diversity factor would only amount to 1.07 That is to say, the sum of the maximum demands upon the various individual stations would only be 7 per cent. greater than the combined maximum demand upon a single station. Under any actual conditions, therefore, with several generating stations at work, it would not appear large enough to make any appreciable difference in cost of plant. Naturally, if tramway or railway loads (having perhaps a 40 per cent. annual load factor) were at the same time carried by the single station, its average load factor, and therefore especially its economy in capital charges per unit, would be increased.

We cannot but concur with the Committee in their concluding remarks :—

"If the scheme is to succeed the co-operation of all the electrical Undertakers within the area is essential, but such co-operation is entirely optional. The Committee trust that they will not be considered as going beyond their reference if they express the hope that the whole of the Undertakers will accept their recommendations, which have been made with only one object in view, and that is the improvement of the electricity supply within the London and Home Counties' Electricity District."

The opening date for the inquiry is June 7.

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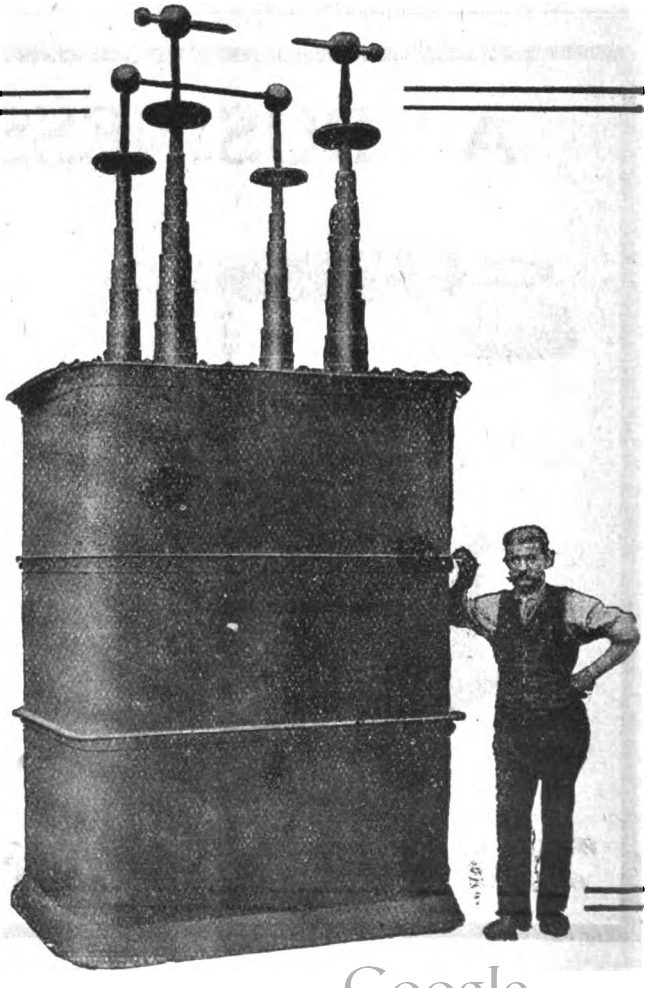
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Mixed Frequencies.

An interesting and illuminating factor of electricity supply in this country is revealed by a chance editorial in an American contemporary. In the direct current field it is a comparatively easy matter to reconcile the diverse standards of voltage affected by different areas, the extreme range of 200 to 250 being fairly well met by the provision of lamps and other current consuming accessories in ranges which will allow of ten volts or so variation from the actual rating without materially affecting the efficiency. In the alternating current field, however, the matter is far more complicated owing to the wide range of frequencies prevalent throughout the country.

Whereas, in the States, there are two leading periodicities to reckon with, viz., 60 and 25 cycles, an analysis of electricity supply undertakings in Great Britain reveals the astounding fact that no less than 15 different frequencies are involved. As my contemporary observes, some of these frequencies may be classed among the freaks and exceptions, their existence being probably due to the desire of certain consulting engineers to stamp their individuality upon a plant in the form of a frequency which is unusual and will not harmonise with other and neighbouring frequencies. The frequencies which come under such a classification include 33, 70, 75, 77 and 93 cycles, with 67.5 as a rank outsider. There are three plants operating at 80 cycles and three at 83. The majority of plants are standardised on 50 cycles, a very convenient figure, common to 223 electricity supply stations.

The next most popular figure is 40 cycles, adopted by 24 central stations, whilst there are an equal number of stations, to the tune of 17 each, operating on 25 and 60 cycles respectively. Nineteen of the older plants affect the early and very high figure of 100 cycles. A brief reflection on these somewhat astonishing figures points several morals. The urgent need for standarisation is at once apparent; with linking-up schemes in process and contemplation, the difficulties are considerably enhanced by the existence of such widely divergent frequencies. Moreover, the need for manufacturing and stocking so many differing windings on motors and other plant to be used on the various circuits does not make for economy or lower production costs. I came across an instance only the other day of the inconvenience and delay associated with this lack of uniform practice. A small motor generator was wanted urgently for a certain job, and a frequency of 50 was assumed by the official responsible for placing the order.

When the machine was delivered the fact came to light that the circuit upon which the motor was to operate had a frequency of 40, and the machine had to be returned to the makers with consequent delay and irritation, to say nothing of the loss of time during which it might have been performing useful work. There cannot be sound arguments in favour of so many different frequencies. One can quite understand that there may be sound arguments in favour of a high frequency for one particular duty and a comparatively low frequency for another, but most engineering achievements are based on compromise, and it should not be difficult to select and standardise a figure which would meet the general requirements of all and sundry. There is one thing certain, that if we ever do achieve the Utopian dream of super-power generation in this country, it will have to be based on a uniform standard both as regards voltage and frequency.

Celluloid Accumulator Cases.

A recent report of the Miner's Lamp Committee on electric safety lamps embodying celluloid cases for the accumulators, once more brings forward the question whether this inflammable and chemically unstable material is really suitable for the manufacture of accumulator cases, whether for miners' lamps or any other type of portable battery. The principal advantages of celluloid for this purpose are its lightness, transparency, and the facility with which it can be manufactured into the familiar battery boxes affected by most makers of small storage batteries. As a convenient substitute for glass boxes where portability is a desideratum there is much to be said for the celluloid case. It is highly desirable at all times to be able to view plates and electrolyte, and thus gain a good insight into the condition of the battery.

On the other hand, celluloid is attacked, sooner or later, by the sulphuric acid, and chemical reactions are set up which must have an influence on the legitimate chemical reactions between plates and electrolyte. Celluloid is not mechanically strong, and in the case of the heavier types of battery has usually to be additionally supported by an outer wood case or crate. Finally, we have the inflammability, a characteristic which has been directly responsible for the accidental destruction of many batteries in process of charging, or even through a short circuit while in service, and has also caused not a few conflagrations of serious dimensions. Introduced into the miner's electric safety lamp, it apparently becomes an additional source of danger (1) through ignition and consequent explosion of firedamp external to the lamp; (2) through the evolution of fumes which might prove dangerous to health; and (3) bursting of the lamp by pressure arising out of the fumes of combustion.

These three sources of danger have been experimentally investigated under the direction of the

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Research Sub-Committee, who report that no danger need be apprehended under (1) and (2), but that (3) is a possible source of danger in those types of lamp assembled by means of a screw joint. This danger also can, however, be completely guarded against by the provision of vent holes in the metal cases of such lamps, which vents, if suitably arranged and of appropriate dimensions, will not permit the passage of flame from within the lamp case.

Whilst a solution has thus been found for the additional problems arising out of the use of celluloid accumulators in miner's safety lamps, it savours rather of putting the cart before the horse. In other words, we first introduce an admittedly dangerous element and then proceed to render it innocuous by roundabout methods involving further complications. It should not be difficult for the lamp makers to dispense with celluloid altogether in these batteries, and thus rid their lamps once and for all of any suspicion should a calamity occur. There is one type of accumulator which can be sealed into an outer steel containing case. The question of sediment and falling paste does not arise with this cell, nor does acid corrosion introduce a difficulty. I refer to the alkaline nickel-iron battery, which, in my personal experience, is ideal for all portable duty, especially where, as in the case of miners' lamps, the problem of a gas and flame-tight seal is all important.

ELEKTRON.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 115.

Can any reader give me some information concerning the testing of steam turbines and generators?—"VACUUM."

QUESTION NO. 116.

I would appreciate full constructional details of a resistance which is to reduce 100 volts to 80 volts when a current of 5 amperes is passing for an indefinite period. How shall I wind the wire? Will mica or enamelled insulated steel tubes be satisfactory?; and what size and kind of wire is most suitable if the temperature is not to exceed 300 deg. F.? The resistance is to be enclosed in a flame-proof box, and the use of oil, for cooling, is prohibited.—"B."

(Replies to Questions Nos. 115 and 116 must be received not later than April 30, 1921.)

NOTE.—QUESTION NO. 110.

No satisfactory replies were received to Question No. 110. This is to be regretted, because what was asked for was merely a description of the design and operation of the small electric motor which slightly increases or decreases the speed of Pelton and Francis wheels to enable water-wheel generators to be synchronised. The majority of competitors merely gave a description of the water wheels, and that is not what was asked for.—THE EDITOR.

GERMAN REPARATION.

Under Sect. 5 of the German Reparation (Recovery) Act, which took effect yesterday, the B.O.T. may by order take certain action, as indicated below:—

(a) Under Sect. 1 of the Act, importers of German goods are to pay to the Customs a prescribed proportion of the value of the goods, not exceeding 50 per cent. The Board of Trade may reduce the prescribed proportion as respects articles of any class, make or description, or may exempt such articles from all the provisions of the Act.

(b) Sect. 2 excludes from the provisions of the Act goods partially manufactured or produced in Germany which are not first consigned from that country, and in which 25 per cent. or more of their value is attributable to processes of manufacture undergone since they last left Germany. The Board of Trade may vary this percentage as respects articles of any class, make or description.

(c) Under Sect. 1, the Act shall not apply to goods imported before April 15, if it is proved to the satisfaction of the Customs that the goods are imported in pursuance of a contract entered into before March 8. The Board may, as respects articles of any make, class or description, substitute some later date for April 15.

(d) Sect. 4 provides that where any person is liable, under a contract entered into before March 8, to accept bills of exchange or make advances in connection with the importation of any goods, he may apply to the High Court; and the Court, if satisfied that by reason of the provisions of this Act, the enforcement of the contract would result in serious hardship to him, may suspend or annul, or with the consent of the parties amend the contract as from such date as the Court may think fit, or stay any proceedings for the enforcement of the contract or any term thereof, or any rights arising under it, on such conditions (if any) as the Court may think fit. The Board of Trade may extend the classes of contract to which the section relates.

The Board are not, however, to make any order under any of the above provisions except on the recommendation of a committee whom they are to appoint, consisting mainly of persons of financial, commercial or industrial experience.

The following committee has accordingly been appointed by the Board of Trade, under Sect. 5 of the Act:—H. A. Trotter (Deputy Governor of the Bank of England), chairman; H. B. Betterton, F. R. Davenport (managing director of Willans and Robinson, Ltd.), Stanley Machin (president of the London Chamber of Commerce), D. Withers (manager, Foreign Branch, L.C.W. and P. Bank), Capt. G. W. Duncan (secretary).

Applications to the B.O.T. to make any order under any of the provisions referred to should be addressed to the Secretary, Great George Street, Westminster, and both the letter and envelope should be marked "German Reparation."

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ELECTRONS.

BY SIR WILLIAM BRAGG, K.B.E., F.R.S.

(*Concluded from page* 146.)

It is a very remarkable fact that the number N is equal to $2\pi^2me^4/h^3$ within small errors of experiment. Spectrum measurements show that N is equal to 3.29033×10^{15} and $2\pi^2me^4/h^3$ is equal, taking the most recent determination of m, e and h, to 3.289×10^{15}. An electron revolving about the central positive nucleus of a hydrogen atom (having a positive charge), and possessing the amount of energy Nh or $2\pi^2me^4/h^2$ moves with a velocity $2\pi e^2/h$ and has an angular momentum equal to $h/2\pi$. The electron if it moves in the next ring does so with an angular momentum $2h/2\pi$ and so on. We can, therefore, following Bohr, define the necessary separate states as those of motion in circular orbits in which the angular momentum is an integral multiple of $h/2\pi$. The simplicity of these expressions is very attractive. But the matter is far from ending here. During the last few years Bohr and Sommerfeld have led an inquiry into the possibilities of this theory which have led to very remarkable results. These are due to a slight modification in the original conception. The different circular orbits which Bohr first pictured have become groups of orbits fixed by laws which are somewhat arbitrary, but not without foundation. A group contains a limited number of orbits in which the electrons may move, and each group corresponds to one of the original circular orbits. Some of the orbits in each group are elliptical. It appears that the energy of the electron would be the same in all the orbits of any one group where it not that when an electron moves in an ellipse its velocity is not always the same. Now a fast-moving electron shows a variation in mass when its speed alters, and this does affect slightly the energy of the orbit. Consequently, the electron that steps from an orbit belonging to one group to an orbit belonging to another group may part with an amount of energy which is not always exactly the same. The frequency of the consequent radiation may, therefore, have two or more values differing slightly from each other; the single spectrum line is doubled or trebled. This is what Sommerfeld calls the "fine structure" of the lines.

Now there is far more than mere speculation in this. The formula which Sommerfeld gives as the result of an analysis which, is as reasonable as can be expected, does more than account for known effects; it has predicted the existence of numerous lines, and even their intensities, and the predictions have been verified by experiment in the most remarkable way. The story is told in Sommerfeld's work on "Atom-building"; a story of the work of himself, Bohr and others during the last six years or so.

We see that in this fundamental inquiry into the nature and properties of radiation, the electron plays a very direct and important part. Our eyes are designed to detect waves, not electrons, and so our first attention is directed to radiation in wave form. But we now find that radiation energy may alternatively be carried by electrons, and that many things become clearer when we appreciate this fact. We can only make further progress in our understanding of radiation, and indeed of our understanding of the electron, by getting to know more about the reciprocal conversion of one form of energy into the other, since evidently it is one of the most frequent and most fundamental operations in Nature.

So far our conception of the structure of an atom would consist of a positive nucleus, and electrons attached thereto in the same way; with the further idea that the energy attached to these electrons can only have certain definite values. Bohr assumes that they have these values because they can move round the core in certain orbits only; and Sommerfeld enlarges this idea as already explained. But, of course, this can only be a partial picture of the whole atomic structure. The atom so conceived cannot fill the part required of it in the building of molecules and crystals.

When we come to examine these structures we find atoms attaching themselves to each other through the action of forces which cannot always be considered as acting from centre to centre. For instance, the arrangement of the carbon atoms in a diamond, as recently determined by X-ray methods, is such that every atom is at the centre of gravity of four others, arranged round it in tetrahedral fashion.

The representation of an atom by a smooth sphere and nothing more would be in agreement with the idea that the properties of the atom in any one radial direction are exactly the same as in any other radial direction, and that any forces between two atoms are between centre and centre. For instance, it has been suggested by Borne and Laudé that the force between two atoms may be of the form $a/r^2 - b/r^h$. This gives an attraction at great distances and a repulsion at small distances, so that the atoms close up together but stay at a certain distance apart as if they possessed surfaces which pressed together. But if that were the case, the carbon atoms would pack themselves together more closely than they do. As a matter of fact, a model can be made in which just twice as many atoms could be packed into any volume as there are already there. We must conclude that there are definite sub-centres of force on the outskirts of the atom: and that in the carbon atoms of which the diamond is composed there are four such sub-centres arranged symmetrically, that is to say, in tetrahedral fashion round the core.

Must not these sub-centres be electrons? And if so, must we not take them to be circulating in small orbits about a local centre? Or, perhaps, as Parson has suggested, the electron is ring shaped, the electricity revolving round the axis of the ring. In this way we should have electro-magnetic forces to link the atoms together.

It is very interesting to observe that in any case the carbon atoms in the diamond are not all oriented in exactly the same way. Taking a cleavage or tetrahedral plane as that of reference, half the atoms will be pointing towards the plane and their neighbours will be pointing away. This ought to make a difference to the X-ray spectra; and it has been looked for at various times, but without success. Lately, however, the improvement in the X-ray spectrometer has been considerable, and I now have no difficulty in finding the expected effect. It is clear, I think, that the carbon atom in the diamond is to be represented as to its properties by a tetrahedron: and that the atom has different properties in different directions, or, as the chemist would say, has directed valencies. There can

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be little doubt that this is so in all atoms. The suggestion is that some of the electrons are tied down to certain regions on the surface, and that not all, if indeed any of them, are at all times revolving round the central core.

When atom joins up to atom it is these sub-centres that are at work; and since atom to atom and again atom to atom make in the end the crystal; and since the crystalline structure is the basis of all solid structure, and is fundamentally concerned with the strength of materials and their temper and all their physical properties, it is easy to see how great is this minute study of the electron.

If this conception of fixed electrons seems to clash with the orbital motions of Bohr and Sommerfeld, we must remember that the clash is between two pictures, both of which are, we know, imperfect. We may expect that on the next occasion when a lecturer tries to tell you what advance has been made in the study of electrons some of these contradictions will have disappeared. Whether this is so or not, I am sure of this, that in the attempt to realise the properties of Nature's unit, the electron, we are working in the true direction towards an understanding of the great problems of radiation, and of material structure.

EX-BRITISH WESTINGHOUSE ASSOCIATION.

THIRD ANNUAL RE-UNION.

Annual dinners of Old Boys and similar associations frequently become stereotyped and therefore boring, finally fizzling out altogether. The Annual Re-union of Ex-British Westinghouse men will be a long time reaching this stage judging by the third gathering at the Holborn Restaurant, London, under the chairmanship of Mr. M. M. Gillespie, on Friday, March 18. The idea of *re-union* has always been prominently before the Committee and the Hon. Sec., Mr. L. S. Richardson, and this year the company of about 150 was "departmentalised" at separate tables seating about eight to ten, appropriately labelled:—Upper Dining Room: G. Aisle, K. Aisle, G. Cooper, A. Punch; Brass Foundry: Transformer Test, Pattern Shop, Paint Shop, Iron Foundry, Dipping Shop, Dynamo Test, Boiler House, and B. Aisle. This plan was a huge success and each member had his corresponding clock card, neither ordinary nor overtime was paid because everything was at "piece" rates, including the toast-list. The latter included "The Association," given by Mr. J. S. Peck and replied to by the Chairman and Mr. J. Turnbull (still bearded); "The Chairman," humorously presented by Mr. R. G. Mercer (who forgot the show was morning dress); and "Absent Friends and Old Associates," by Mr. G. Layton; Major O. P. L. Hoskyns called on the company for the "Silent Toast to the Memory of Ex-B.W. Men."

The items in the musical programme by Miss Muriel Macgregor, Mr. A. P. Ambler, Mr. Val. Wood, and Mr. H. S. Aspinall were just sufficient not to interfere with the renewal of old friendships. The members also had opportunity to exhibit their vocal powers in the opening and closing chorales: the latter to the tune of "John Brown's Body."

During the evening occasion was taken to make a presentation to the Hon. Sec. and Re-union Agitator, Mr. L. S. Richardson, for the valuable services he has rendered in assisting the formation of the Association and organising the first three functions. The gifts were an after-dinner coffee set with silver spoons, a gold watch fob, and a gold bracelet-watch for Mrs. Richardson. Mr. Aspinall introduced the subject in a speech of appreciation and thanks, and Mr. Gillespie made the presentation in a particularly happy manner. Mr. Richardson, in reply, mentioned from experience how little incidents often made great impressions and that it was undoubtedly that *esprit de corps* from the managing director downwards, which existed in the old days, that made it always a pleasure and privilege to assist in keeping fresh old B.W. friendships.

The souvenir programme was in great demand and no further copies are now available. Ex-B.W. men are reminded that new names and over-due "subs" (without which the good work of the Association cannot go on) should be sent to the Hon. Sec., Mr. L. S. Richardson, 14, Sydney Road, Richmond, Surrey.

VICKERS-PETTER SEMI-DIESEL OIL ENGINES.

A handsome, well-illustrated 50-page catalogue of Vickers-Petter semi-Diesel crude oil stationary and marine engines, embracing sizes from 10 to 450 b.h.p., has been issued by Vickers-Petters, Ltd. (Ipswich Works, Ipswich). A number of important new features are described, including a patented electric starting device. It consists of an electric heater, fed from a battery, charged by a dynamo attached to the engine, and enables the engine to be started instantly on crude oil without external heating, and dispenses with the need for paraffin. As soon as the engine is started the current is switched off and ignition maintained by the heat of combustion. The device is so designed that the heater is only exposed to the heat of combustion for a few minutes and is not liable to get burnt out. The equipment includes two storage batteries of 100 amp.-hours, one being a spare, one spare heating element, and a complete generating set with switchboard and instruments for charging the battery from the engine. A lamp switch is also provided, enabling one or two electric lights in the engine room or elsewhere to be connected to the battery.

It might be mentioned that Vickers-Petters, Ltd., are the pioneers of semi-Diesel crude oil engines. On the 29th ult they opened new London offices and showrooms at 75b, Queen Victoria Street, E.C.4, while branch offices are to be found at Bristol, Glasgow and Dublin.

MERCURY ARC RECTIFIERS.

At the meeting of the Informal Section of the Institution of Electrical Engineers on Monday, the 14th ult., with Mr. A. B. Eason in the chair, a discussion was opened by Mr. R. L. Morrison on Mercury Arc Rectifiers and was thoroughly successful.

The opener was furnished with some good photographs of the rectifiers in service and with excellent charts and drawings, including one full scale of a 900 amp. converter.

He explained the function and construction of the rectifier and the utilisation of each half wave by the two halves of the transformer centrally connected. Mr. Morrison claimed superiority for the Mercury Arc Rectifier chiefly because of its general high power factor, saving in floor space and weight, also because it is noiseless, vibrationless, stationary, and requires no heavy foundations.

Then followed a keen and animated discussion, opened by Mr. G. A. Juhlin. He thought the simplicity of the apparatus was bound to occasion its adoption and development, but disputed that rotary converters were at a disability. He also asked for information regarding possible interferences with telephones due to the ripples and harmonics.

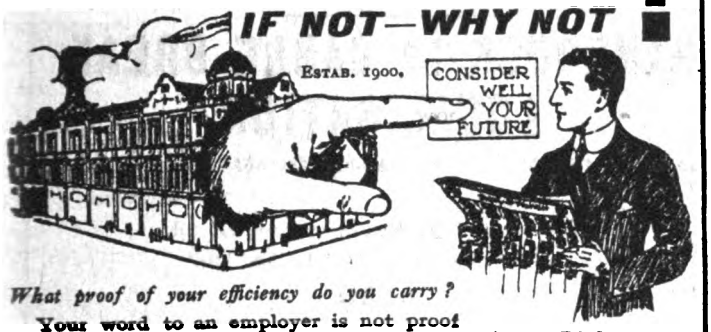
Mr. W. E. Rogers, Mr. W. E. Bradshaw, Major R. Grierson, Mr. P. Kemp, and thirteen other speakers (C. A. Newell, E. W. Moss, A. G. Hilling, W. H. J. Holloway, J. Aylmer, W. L. Wreford, M. R. Gardner, A. B. Eason, F. Pooley, H. M. Sayers, H. Gooch, E. W. Webb, and G. A. Cheetham) followed.

The general trend of the discussion was very critical, and Mr. F. Pooley, who spoke late in the evening, urged that antipathy to the novelty of the apparatus was hardly constructive. Nevertheless, some most useful ideas were mooted, and the evening was extremely interesting.

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Mr. Morrison, in his reply, was able to point to extensive installations of the rectifiers, and though he agreed the experience of them is only of a few years' duration, the makers were able to declare that the renewals and maintenance charges were negligible. With regard to telephone disturbances, no data were available, but no complaints were known of. Research and developments are proceeding and at an early date it is anticipated any d.c. ripple will be entirely eliminated.

TELEGRAPHY.

Being Solutions to the Questions set in the Final Examination in Telegraphy held by the City and Guilds of London Institute in April, 1920.

(*Continued from page 165.*)

Q. 3.—Show, in diagram, the arrangement you would adopt in order to provide two double-channel circuits on an underground loop, and state how the electrostatic capacities would differ.

A. 3.—Two duplex circuits may be provided on an underground loop by superposing one circuit on the other. The arrangement adopted is shown in Figure 2, which represents the connections at the up station.

One circuit, known as the loop circuit, is worked round the loop from an unearthed battery. The other, known as the plus circuit, is worked over the two lines of the loop in parallel from an independent earthed battery.

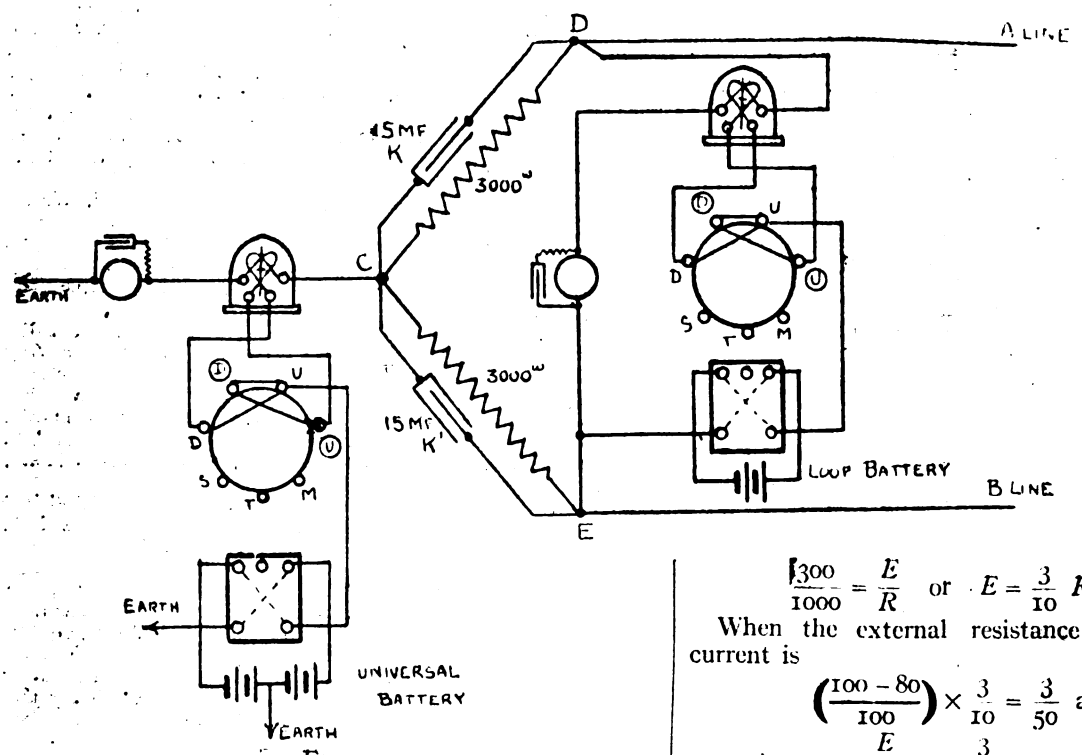


FIG. 2.

The bridge-arms CD and CE have the same resistance, which is approximately equal to that of the line. Signalling condensers K and K' are joined across them as shown in order to nullify the retarding effects of line capacity upon the speed of the plus circuit.

As both sides of the loop circuit from the point C to the corresponding point at the distant station are equal in resistance and capacity, it follows that the potential difference between the points D and E will not be altered by currents sent by the plus keys, and the loop apparatus will therefore be unaffected. Also, as the loop apparatus works from an unearthed battery, it can only work round the loop and cannot interfere with the plus apparatus.

In order that the circuits may work simultaneously without interfering with each other it is essential that the two lines of the loop should have exactly the same resistance, capacity, and insulation.

If k is the wire to earth capacity of each wire of the loop, then the electrostatic capacity of the loop circuit will be $\frac{k}{2}$, because it is equivalent to two condensers each of capacity k, joined in series.

For the plus circuit the electrostatic capacity will be $2k$, because it is that of the two wires of the loop to earth, which is equivalent to two condensers each of capacity k, joined in parallel.

Theoretically, the electrostatic capacity of the plus circuit is therefore four times that of the loop. In practice, however, this does not actually obtain, because the signalling condensers at each end increases the capacity of both circuits.

Q. 4.—A battery produces a current of 300 milliamperes when its terminals are joined by a wire of negligible resistance, and when the battery circuit is completed through a resistance of 1,400 ohms the current is reduced by 80 per cent. Calculate the electromotive force and resistance of the battery.

A. 4.

Let E = E.M.F. of the battery, and R = resistance of the battery, then when the external resistance is negligible we have by Ohm's law

$$\frac{300}{1000} = \frac{E}{R} \quad \text{or} \quad E = \frac{3}{10} R \quad \ldots\ldots (1)$$

When the external resistance is 1400 ohms the current is

$$\left(\frac{100 - 80}{100}\right) \times \frac{3}{10} = \frac{3}{50} \text{ ampere,}$$

$$\therefore \quad \frac{E}{R + 1400} = \frac{3}{50} \quad \ldots\ldots\ldots (2)$$

Substituting the value of E from (1) in (2) we have

$$\frac{\frac{3}{10}R}{R + 1400} = \frac{3}{50}$$

$$\text{therefore} \quad 5R = R + 1400$$

$$\text{or} \quad 4R = 1400$$

$$\text{so that} \quad R = 350 \text{ ohms}$$

$$\text{From (1)} \quad E = \frac{3}{10} R = \frac{3}{10} \times 350 = 105 \text{ volts.}$$

(*To be continued.*)

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Various Items.

N.W. Mid. Electricity Dist.—Time limit for objections, etc., has been extended to July 30.

Burry Port.—Mrs. W. T. Edmunds, the wife of the chairman of the U.D. Council, inaugurated the electric lighting scheme of Burry Port last Friday evening, when that town was illuminated for the first time with the aid of electricity.

Smoking Concert.—A Smoking Concert has been organised by the Manchester and District Local Advisory Committee of the Electrical Trades Benevolent Institution, which will take place at the Albion Hotel, Piccadilly, Manchester, on Friday, April 1.

The G.E.C. Moves.—The General Electric Co., Ltd., announces that on and after Monday next, the 4th inst., the Head Office, Sales Depts. and Stores will be situated at Magnet House, Kingsway, W.C.2. Until further notice, however, the showrooms of the Company will remain at 67, Queen Victoria Street, E.C.4. The new telephone number is Regent 7050 (50 lines), and the telegraphic address: "Electricity, Westcent, London."

South African Ry. Electrification.—Generating plant, substation plant, locomotives, etc., are required for the electrification of the Capetown-Simonstown, and Durban-Pietermaritzburg Lines. Tenders are required to be lodged at office of the High Commissioner for the Union of South Africa in London by noon on May 3. Consulting Engineers: Messrs. Merz and McLellan, 32, Victoria Street, S.W.1.

Pinchin, Johnson & Co., Ltd.—The Annual General Meeting of this large and old established firm of varnish, colour, paint and enamel manufacturers was held at the Reg. Offices, General Buildings, Aldwych, W.C.2, on the 21st ult. The Chairman was able to refer to very satisfactory results all round, the ordinary shareholders are to receive a dividend of 15 per cent. for the year. Stocks have been written down and the Company is in a position to deal efficiently with a much greater volume of business than ever before. The Company looks forward with every confidence to the year 1921.

Montreal.—A firm wishes to get in touch with British manufacturers of small motors. The type now required is "Universal" 115 volts, for either A.C. or D.C., 25 to 60 cycles, about ⅛ h.p., approx. 3,600 r.p.m., with rheostat for controlling speed. The quantity required is about 900 per month with a probability of larger quantities being desired in the near future. The motors are required for a small portable motion picture machine, for which a sewing machine motor measuring about 4 in. long by 3½ in. dia., which is found to give fair satisfaction, is at present being utilised. Further particulars from B.O.T. Dept. of Overseas Trade.

Originality in Technical Advertising.—Considerable experience is required in the planning of arresting advertisements, and although many engineering firms now realise this as regards a proportion, at least, of their advertisements, there are still thousands who do not reap the fullest benefit from the space they take, simply because they do not bestow the necessary care on the design, arrangement and choice of types used—even if the basic idea is good. In this connection most, if not all, technical advertisers should find of interest the matter and illustrations in a booklet issued by Ernest Ingram Hill, Technical Advertising Service, 29 Ludgate Hill, E.C.4.

Help the Foreigner.—There is nothing like doing your best to help push British trade into the hands of a foreigner, at any rate that is the view taken and very consistently followed up by one of the contributors of our contemporary, the *Electron*. In the current (April) issue he says, that all credit is due to the joiners for the fight they are putting up which is sending such a large amount of ship work over to the Continent. There is no doubt that our Continental competitors are delighted to have orders, and we don't blame them, and we feel certain that London members of Electrical Trades Unions, under their present wise (?) leadership, will go on doing their best in this direction. Another point is that they do not wish us to remain in occupation of German territory or to make Germany tax its population in order to pay France and ourselves and thereby reduce our taxation. They would much rather have the Germans free to compete with us in our foreign markets and also in our home markets here. That's just it—any country rather than your own. Some of the ex-Service men don't quite agree, but what do the E.T.U. members care for that?

Meetings.—The Junior Inst. of Engineers will meet on Friday, 1st inst., at 39, Victoria Street, at 7.30 p.m. Lecturette, "Pneumatic Conveyors," by Mark Jennings (Member). Also on Tuesday, 5th inst., Visit to the Works of the Tunnel Portland Cement Co., Grays, Essex. The party will assemble in the booking-office of Grays Station at 2.50. And on Friday, 8th inst., at Caxton Hall, at 8 p.m. Questions and General Discussion.

Trade Notes.

Z Electric Lamp and Supplies Co., Ltd. (73, Newman Street W.1), announce a reduction in price of the "Electrolux" Suction Cleaner, made possible by increased production due to the large demand.

The **Edison Swan Electric Co., Ltd.** (Ponders End, Middlesex), have issued a 28-page list (No. P.P.213), dealing with Ediswan petrol-electric lighting and pumping sets. Illustrations, specifications and prices are given.

The "Elastalite" candle lamp is illustrated and priced in leaflet No. C.L.I., issued by **Pope's Electric Lamp Co., Ltd.** (5, Arthur Street, W.C.2) It is of simple design with no wearing parts, and is held rigid in the lampholder by a threaded collar.

"Electrical Industries," published weekly since 1901, by the **Electrical Press, Ltd.**, desire to give notice that it has no connection with a Company entitled Electrical Industries, Ltd., a trading concern, registered in May, 1920, and now in liquidation.

A folder issued by **Laurence Norris & Co.** (Imperial Buildings, 54-6, Kingsway, W.C.2), gives particulars of ball bearings of the leading makes in stock (the number in stock being given). The company further state that the range of sizes is the largest available immediately from stock in this country and their prices the lowest.

L. G. Hawkins and Co. (116, Charing Cross Road, W.C.2) are utilising in the promotion of the sales of "Universal" vacuum cleaners, irons, toasters, coffee pots, etc., a poster advertising a special price for a complete set of these items—all of which they demonstrate to the consumer. A folder, "Domestic Service Electrified," is also being issued for dealers.

List No. 860. "Simplex Lighting Fixtures, 1921," is a distinctive pocket size publication of 52 pp., illustrating and pricing direct and semi-indirect lighting fixtures of all kinds. Reference is also made to outside lighting, window lighting, Simplex illuminated signs, etc. Contractors and dealers will find it most convenient and should write to **Simplex Conduits, Ltd.** (Garrison Lane, Birmingham, or 113-7, Charing Cross Road, W.C.2).

We have received from the **Metropolitan-Vickers Electrical Co., Ltd.**, 20, Brazennose Street, Manchester, leaflets Nos. 379/1-1 and 379/1-3, giving illustrations and descriptions of three-phase transformers for rotary converters; and leaflet No. 711/1A, dealing with transformers specially designed for use in collieries. With regard to the transformers for reactance control of rotaries (operation A.C. to D.C., and total D.C. voltage range not exceeding 12½ per cent.) the provision of the necessary reactance is by means of a patented multiple gap shunt consisting of packets of laminated iron mounted together vertically and separated by non-magnetic material. This construction forms a multiple gap shunt so arranged that the laminations of the shunts lie in the same plane as the laminations of the transformer core, between the H.T. and L.T. windings, and held firmly between the top and bottom yokes. Reactance of any value required by the rotary and possessing a straight line characteristic of reactance volts with current up to 50 per cent. overload can be provided.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
APRIL 8, 1921.

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ELECTRO-PLATING.

By C. Sylvester, A.M.I.E.E., A.M.I.Mech.E.

[Note.—It is a curious fact that, although electro-plating is in such demand at the present time, there are very few plating plants in existence. In the Midland counties, in some of the large engineering centres, some fairly large firms send their work out to be plated. Thus we see one or two plating companies in these districts who really cannot cope, at times, with the demand upon their limited resources. It should be the object of every firm dealing with metal work to have their own plating plants. This would eliminate the inconvenience caused through waiting for material when it is urgently required, and it would result in all-round efficiency. In this series of articles Mr. Sylvester will deal exhaustively with the subject of electro-plating from the lay out of the plant to the plating of finished articles. With the aid of these notes it should not be a difficult matter for the small manufacturer to install his own plant.— Editor, Electricity.]

When considering the subject of electro-plating it should be remembered that the scientific basis by which electro-plating is carried out is the same whether the process is conducted by an amateur or the largest plating company in existence. The apparatus required, however, varies to meet the requirements of the quantity of work it is proposed to dispose of, but the principle of working remains the same.

Size of Plant.

It is hardly possible in these articles to lay down any hard and fast rules concerning the size of plating plants, since the conditions under which the plant will be operated will always be varying. Again, in one district it may be necessary to plate large articles, yet in other districts there will be no article larger than a terminal to be plated. It may be said, therefore, that the size of plant will be dependent upon the size of the articles to be plated, and the finish or quality of the plating desired. When these conditions are known, then the size of the plant may be determined, but, in all cases, arrangements should be made for the extension of the plant as far as is possible.

The Plating Shop.

It is hardly necessary to say that the plating shop should be on the ground floor. The walls may be built of either wood, brick or iron, but the floor should be either of brick, cement, or concrete gradually sloping to allow water to drain off into a gutter. The plating vats should be arranged upon low pedestals of concrete about six inches high, to allow the air to circulate under the bottom of the vats, and to prevent the water rotting the wood. The latter would be the case if the vats were on the floor.

Polishing and Finishing Shops.

The position of these shops will depend upon the amount of space available. They are much better situated away from the plating shop altogether, although not at too great a distance. The passages between the plating and polishing shops should be covered in to protect the material from rain or snow, etc. The light in these shops should be as good as is possible, so that the workmen can see the progress of the work quite easily. This is most essential, because any changes of colour with the work should be detected at once.

Heating of Plating Shops.

Practically the whole of the operations carried out are with different solutions which have to be heated. The two best agents for heating are gas and steam. In very small plants gas will be very convenient and inexpensive. Larger plants, however, should be heated with steam. Although the machinery may be driven by electric motors from an electrical supply company, it will be economical to obtain a boiler to provide the steam for heating purposes. Of course, where the electricity is generated on site, a supply of steam may be taken from the main steam range for this purpose.

The Plating Dynamo.

Dynamos used for electro-plating usually have a large current capacity with a voltage which may be regulated between 2 and 8 volts. They are shunt wound and the shunt current is, of course, very large. A regulating resistance is inserted in series with the shunt field so that the generator voltage may be regulated. The importance of efficient regulation cannot be over-estimated, because it is upon this that the quality of the work depends. It is therefore necessary that an excellent contact should be maintained between the regulating steps of the shunt field rheostat, because the slightest increase of resistance, due to bad contact, will immediately cause the voltage to drop to zero, and the polarity of the machine may be reversed. This is possible with plating dynamos, although they are shunt wound, due to the very low resistance of the armature, in comparison to the shunt winding.

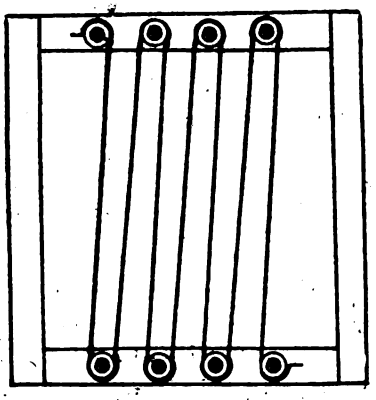


Fig. 1.

Fig. 1 illustrates the construction of a rheostat such as is used with plating dynamos capable of delivering 2,000 amperes. The shunt current of such a dynamo would probably be, under full load, between 25 and 40 amperes. The illustration shows eight sockets round which a piece

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of thick wire of high resistance is stretched. Good electrical contact is made to each socket through the agency of studs and nuts.

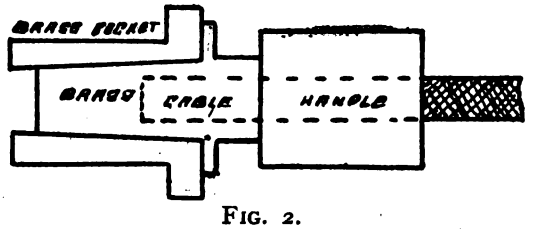


FIG. 2.

Fig. 2 illustrates the construction of the socket. It will be seen from this diagram that the cable is soldered in a tapered brass end, the taper fitting very neatly in the socket. A grooved handle allows the necessary twisting to make good contact between the cone and the socket. The cable is flexible, of finely stranded copper wire, sufficiently large to allow the maximum shunt current to pass without heating in the slightest degree.

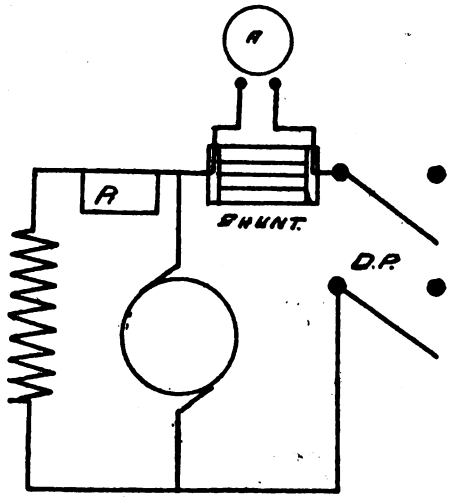


FIG. 3.

Fig. 3 illustrates the arrangement of circuits. In this diagram, R is the rheostat and A is an ammeter, which is operated by the shunt. A double pole circuit breaker, D P, completes the arrangement as far as the dynamo is concerned. The circuit breaker should be of the overload type so that it will trip in the event of overload.

(To be continued.)

THE WORK OF THE INDUSTRIAL LEAGUE AND COUNCIL.

The report for the year ending September 30, 1920, indicates that during the twelve months all the great manufacturing centres in the U.K. were visited by emissaries of the organisation. Active branches are in operation in Manchester, Leeds, Birmingham, Deptford, Eastbourne and Southwark, and other towns in which committees are being formed include Leicester, Bristol, Portsmouth, Coventry, Glasgow, Hartlepool, Blackburn, Walsall, Halifax, Bedford, etc.

The number of meetings which have been held and addressed run into four figures, and it is interesting to note the character and variety of organisations that have appealed to the League to provide lecturers on industrial subjects. It is perhaps an indication of the growing interest which is nowadays being manifested in economics by all sections of the community.

Fifteen conferences of a national character were held and were attended by 700 employers, 60 employers' associations, 800 trade unionists and 460 delegates from trade unions, representing a membership of one and a half millions. It is undoubtedly a healthy sign to find so many employers' organisations and prominent trade unions evincing an active interest in the objects of the work of the Industrial League, and it encourages one in the belief that both employers and employed are as a matter of fact realising that the prosperity of industry is a matter of vital concern to all engaged in industry, and that only by co-operation can each ensure their individual and collective well-being.

The annual general meeting is being held on the 13th inst. The chairman at the ensuing dinner will be the Rt. Hon. G. H. Roberts, M.P., and the guests, Col. Sir Wm. Dupree, and Mr. J. O'Grady, M.P. (Sec. Nat. Fedn. Gen. Workers).

ELECTRICITY IN THE HOME.

During the the recent successfull local exhibition of electrical appliances at Aylesbury, where the progressive borough council is pushing the sale of electricity for other purposes than lighting, Mr. J. W. Beauchamp gave two lectures on the utility of electricity in the home. He emphasised the salient features of many appliances seen in use in the hall, but did not enlarge upon the virtues of the "all electric" home, though he advocated as a practical proposition for to-day the house which contained one fire, consuming coal and having a hot water boiler attachment, then having electric plugs fixed in all other rooms, to allow of the use of an electric fire and lighting when and where required. The kitchen should also be fitted with electric lighting, and a plug for the iron, etc. The advantages of electricity in the home included, he said, the absence of fumes and ashes in cooking; labour was saved, and the appliances were portable.

ALL ABOUT TRAMWAY MOTOR BURN-OUTS.

By H. S. B. Robinson.

Although it is often assumed that tramway motor burn-outs are due to overheating, it should be remembered that in general tramway practice much of the time is undoubtedly occupied in stopping and starting, coasting and working at less than full power, consequently the motors only work for a comparatively small part of the time at the full supply pressure. Taking into consideration the fact that the iron loss in the motor and the heating due to it depend directly upon the voltage, it will be seen that the chances of burn-outs being caused through overheating are extremely remote.

Reference has already been made elsewhere to the various causes of armature troubles, together with a practical method of overcoming the difficulty should the damage be slight; it is therefore intended to devote the following remarks to rewinding in the event of the "patching-up" process previously mentioned being considered useless. If the armature is to be wound with wire coils it will be found more convenient not to put the commutator in position until the winding is complete, as all the coils should be on the core before any connecting is done. If, on the other hand, the winding consists of strap coils, the commutator should be put on the shaft before any of the coils are placed in the slots. After the old coils have been removed and the core thoroughly insulated, the first

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coil is placed in position, the bottom half of which should be inserted in the slot and the top half into its corresponding slot, and so on until the winding is nearing completion. It will then be found necessary to raise the top halves of the coils to allow of the bottom halves being slipped in under them into their respective slots. Should the coils not go easily into the slots they should be rubbed with paraffin wax, the insulation thus remaining uninjured and absolutely uniform during winding.

The connecting leads to the commutator should be uniformly bent to their proper position and their tinned ends then turned upwards, after which the commutator should be pressed on to the shaft. When all the bottom leads have been placed in the commutator bars, a magneto or lamp test should be made by placing the terminals of the magneto or lamp circuit on successive adjacent pairs of commutator bars to find if there are any short-circuits either in the commutator or the coils. A few layers of treated surgical tape should then be put over the leads right up to the back of the commutator neck to insulate them from the top ones. The top leads of the coils are then placed in position in a similar manner to the bottom leads, and after the commutator has been fully connected, and before the connections are soldered, a further magneto test must be made between adjacent bars. If the bell does not ring in every case, there is an open circuit, due to the leads being crossed at that point, or at one diametrically opposite, or to two breaks in the coils. It is also advisable to test the insulation between the core and the winding with at least 1,000 volts above the normal voltage of the machine. When the number of commutator bars is the same as the number of armature slots, all the leads from one side of each coil are connected to the same bar, the coil sections being thus connected in parallel. When the number of commutator bars plus one is twice the number of armature slots, half the leads from one side of each coil are connected in parallel to the commutator, except those of the spare coil section at the end of the winding, which obviously has no corresponding bar. The spare top and bottom leads of this coil are cut off about one inch from the end of the cells, and insulated with tape. The arrangement of the winding on the two-circuit principle not only secures perfect balance of armature circuits when the armature is considerably out of centre, but is largely responsible for sparkless commutation under all conditions of load. Three steel wire bands serve to retain the coils in their places in the slots. These band wires are wound in grooves in the core of such depth that the wires do not project above the surface; the maximum clearance is thus available to allow for eccentricity of the armature in the field caused by wear of the bearings. Moreover, should undue wear allow the core to touch the pole faces in revolving, the band wires are protected, and will not break and allow the armature coils to be thrown out. The ends of the coils, clear of the field poles, are further secured by two bands of steel wire, which prevent coil spreading in case an excessive speed should be attained. All armatures when completely wound must be dried out, then thoroughly painted with insulating varnish. The drying may be done in a heater, or by passing current through them, the former being the better method.

THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.

By Sir William Noble, M.I.E.E.

(*Paper first received December* 16, 1920, *and in final form February* 10, 1921.)

SUMMARY.

This paper describes the development of the trunk telephone system since 1905.

It deals mainly with the improvements in line plant design, especially in underground cables, which have been made in the past ten years.

The expansion of the trunk-line system since 1905 led to congestion of the pole lines along roads, railways and canals; and the difficulty of finding new routes increased. Improvements in underground long-distance telephone cables led to a solution of this difficulty: and the new trunk-line system is to be almost entirely underground.

Some details are given of the early work of Post Office engineers in devising methods and apparatus for balancing underground cable circuits so as to render them free from mutual interference or cross-talk. This early work led up to the modern precision methods of cable balancing which were first applied to a cable laid between Leeds and Hull in 1913. Details are given of the second balanced cable, namely, that laid between London and Liverpool in 1914; and the problems created by the success of this cable are discussed.

The telephone repeater became a practical proposition when the 3-electrode thermionic amplifier was evolved; and the general introduction of telephone repeaters into long-distance lines has led to what is almost a revolution in long-distance communication schemes.

The methods of duplexing the thermionic amplifier in order to obtain both-way working are described, and details are given of the methods of measuring the impedance/frequency characteristics of telephone lines for the purpose of constructing the artificial line balances required for duplex working.

The scheme of introducing telephone repeaters into the trunk-line system is explained and the economies to be effected in line plant are discussed.

A map of the proposed main underground-cable system is given.

In submarine telephone-cable work there has been continued progress since the reading of Colonel O'Meara's paper in 1910, and some details are given of the latest developments, especially in the direction of continuously loaded cables.

The paper concludes with a reference to the introduction of high-frequency carrier-wave telephony and its application to long-distance communication.

The subject of this paper has not been brought before the Institution since 1905, when Sir John Gavey (then Mr. Gavey) in his Inaugural Address referred to the trunk telephones. Previous to that Address, the *Journal* of the Institution contains only one paper dealing with the subject, namely, Mr. Gavey's paper on "The Telephone Trunk System in Great Britain," presented in November, 1896.

I feel, therefore, that no apology is necessary for introducing the subject after this lapse of time, especially as it is one that has recently received considerable attention in the public Press and technical journals. In his inaugural address in 1905 Sir John Gavey referred to two fundamental problems which at that time awaited solution: first an effective telephone relay or repeater, and secondly a method of extending the range of communication in submarine cables.

The second matter was dealt with by Colonel W. A. J. O'Meara in December, 1910, in his paper read before the Institution entitled "Submarine Cables for Long-Distance Telephone Circuits." In the interval between 1910 and the present time a solution of the first-named problem has been found, and this has led to the developments which I propose now to describe.

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During the past four or five years the whole art of long-distance telephonic transmission has been almost completely revolutionised by the evolution of the three-electrode thermionic tube amplifier and its use in the telephone relay or repeater. An earlier opportunity would have been sought to describe the character of this revolution in view of its far-reaching effects on the design and manufacture of telephone plant of all kinds, but the circumstances of the Great War made such a course impossible.

My task this evening, however, is much facilitated by the fact that since the Armistice was declared several papers dealing with the thermionic valve amplifier have been printed in the *Journal* of the Institution, and the subject has received widespread attention in the technical Press. I am therefore able to assume that the theory of the thermionic valve and the methods of using it as an amplifier of telephonic currents are well known to the members of the Institution: and consequently I may deal more fully with the effects of its introduction into telephone engineering.

At the present time long-distance telephony divides along two main lines of development, namely:—

(*a*) Communication between the principal commercial centres of the country.

(*b*) Communication with remote districts, and international communication.

In the former the demand is for the provision of large numbers of circuits over distances up to 450 miles, e.g., London and Manchester, London and Glasgow; whereas in the latter the requirement is for a very few circuits, in most cases one or two only, over much longer distances, e.g., London to Belfast, London to Brussels, Paris and Marseilles, and in due course to Rome, Madrid, Constantinople or even Cairo.

Each line of development presents distinct problems of engineering design.

In the first decade of the present century it appeared that the ultimate possible efficiency in long-distance telephone transmission had been reached; and that it was attainable only by the employment of the heaviest practicable copper conductors, erected on aerial lines, highly insulated, and revolved in pairs or quadruples to reduce inductive disturbances to a minimum. In this country the maximum economical conductor was proved to be one weighing 600 lb. to the mile. A few circuits with 800-lb. conductors had been erected in the last decade of the 19th century, but their very small advantage in transmission efficiency as compared with 600-lb. conductors within the distances to be covered in this country did not compensate for their much greater capital and annual costs.

On the basis of a total attenuation of $Bl=2.5$ (representing a ratio of about 7½ per cent. as between the received and transmitted currents, that is a loss of 92½ per cent.) as being the limit for a commercial long-distance line, the maximum length of a 600-lb. circuit was about 900 miles.

In this country, however, it was never possible to obtain the maximum efficiency of an aerial circuit on account of the necessity for short lengths of underground cables in passing through intervening town areas or across physical obstructions, such as river estuaries, etc., and 60 per cent. efficiency was the average obtained in practice.

Even under these conditions good commercial service was given between centres so far apart as London and Glasgow, London and Dublin, London and Paris, and London and Brussels; and the lines available for these services had a fair margin of efficiency for extension to minor telephone centres in their respective areas.

From the time of the taking over by the Post Office of the trunk telephone service in 1896 until about 1910 it was possible to accommodate on pole lines along the public roads and railways all the wires required to meet the public demand for trunk service. The following table shows the increase in the number of trunk circuits radiating from London to the more important provincial centres.

It will be realised that the pole lines carrying these circuits radiating from London must carry in addition the shorter circuits connecting towns lying on the routes.

For example, one of the London-Manchester lines passes through Northampton, Leicester, Derby and Buxton, and carries circuits serving those towns. Moreover, the requirements of the telegraph service have also to be met.

TRUNK CIRCUITS RADIATING FROM LONDON TO PROVINCIAL TOWNS.

	1902	1905	1908	1914–15	1920	Estimated 1925	Estimated 1930
Birmingham ..	4	7	14	32	37	60	76
Liverpool	8	10	14	35	37	63	80
Manchester	6	6	10	17	21	47	61
Leeds	2	2	9	13	14	20	24
Newcastle	1	2	8	10	9	14	17
Glasgow	4	4	4	6	5	10	12
Bristol	3	5	6	15	17	27	30
Cardiff	2	4	10	14	18	26	29
Southampton ..	1	4	6	11	11	20	25

The congestion on the main aerial lines was becoming serious in 1910, and it was practically impossible to find road routes for new pole lines, especially in the approaches to London. The traffic-development studies undertaken about that time forecasted a demand for trunk lines which could not possibly be met by any ordinary system of road pole-line construction, and a scheme of direct cross-country routes of steel tower construction capable of carrying very large numbers of conductors was prepared. At this juncture, however, the results of a long series of experiments on the loading of telephone circuits with inductance coils, in accordance with the principles described by Pupin in 1900, indicated another line of development of the trunk telephone system. The earlier experiments with loading in this country were made with inductances of the air-core type, but these were replaced later by the improved iron-core types introduced by the Western Electric Company of New York. Under the favourable climatic conditions of North America, the American Telegraph and Telephone Company had obtained an improvement factor of 2.5 on the transmission efficiency of aerial lines, but in this country the climatic conditions were much less favourable, and even if the American standard had been attainable, and the weight of copper in aerial circuits correspondingly reduced, the problem of relieving congestion of the pole lines would have still remained. The results obtained by the loading of underground telphone cables with inductance coils were, however, more encouraging, and the attention of the Engineering Research Department of the Post Office was therefore specially directed to this line of development. The manufacture of dry-core paper-insulated lead-covered telephone cables had already reached a high stage of perfection, and the cables produced by the manufacturers of Great Britain were, and are still, the best obtainable in the world.

The history of the development of the long-distance telephone cable is a record of undaunted perseverance in the solution of scientific and practical engineering problems which cropped up persistently as progress was made, and which frequently appeared to be insuperable. It will be instructive to review the various stages of progress in this development, and to recall the difficulties and the methods of overcoming them.

(*To be continued.*)

Accrington.—The Electricity Committee have received a letter from the Electricity Commission in reply to their application to borrow money for an extension of the electricity station, intimating that in view of the establishment of the new generating station at Blackburn, they would like the Council to consider the advisability of taking a bulk supply from there in preference to extending the existing station at Accrington. A communication has been addressed to the Electrical Engineer at Blackburn to ascertain whether a bulk supply can be obtained, and if so when and on what terms.

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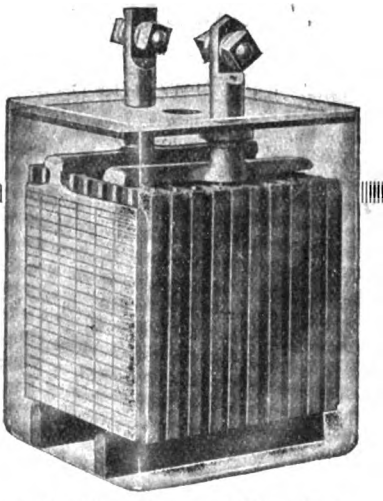
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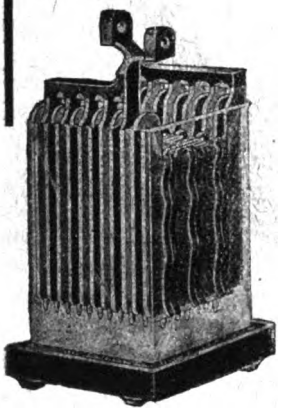
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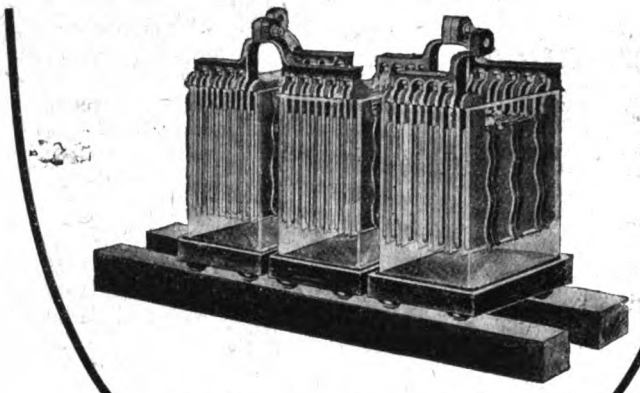
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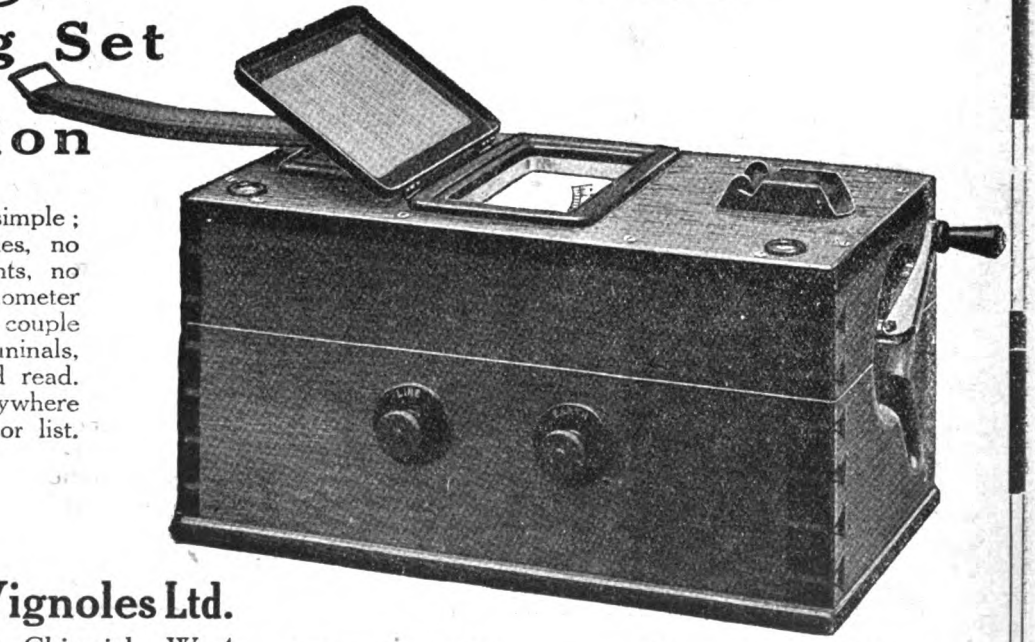
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

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Current Topics.

Research Dangers.

The recent death of a distinguished specialist in X-Radiology, Dr. Ironside Bruce, again serves to direct attention to the dangers which beset earnest workers along the various lines of advancement and discovery opened up by scientific study. Dr. Bruce is by no means the only victim to X-rays, which, in spite of their invaluable properties and the vast amount of suffering they have prevented, are a distinct source of danger to human beings who are constantly exposed to them. The effect of the rays in destroying certain tissues of the body and setting up incurable sores was very early realised, but even to-day, and in spite of the precautions which are generally recognised as necessary for safety, this adverse characteristic of X-rays is not thoroughly understood.

There is scarcely a single discovery in the realms of science which has not, sooner or later, caused loss of life until its effects have come to be analysed and comprehended by those in close contact with the work of research, and the dangers attendant upon modern research are not likely to deter our present generation of scientific workers from carrying on this great work for the benefit of mankind. Such mishaps all tend to prove the truth of the old adage, "A little knowledge is dangerous," and unfortunately the victims are usually of a highly intelligent and enterprising order whom civilisation can ill spare. We have yet many unknown problems to solve in the realm of radiation, whilst the electronic theory of electricity opens up fascinating fields for future discovery. We may be on the verge of some epoch-making discovery, and it behoves all concerned in research work, whether of this or any other description, to take every precaution dictated by known facts to ensure their own personal safety. We can ill afford to lose our pioneers of science.

The Limit of Useful Life.

The so-called "life" of any article or plant in everyday use is an extremely variable factor, depending on a number of influences, all of which tend at last to destroy its utility and bring it to the condition generally known as "worn out." Ordinary wear and tear are unavoidable, especially where moving machinery is concerned. Friction, vibration, crystallisation, and other factors all enter into the question of useful life of such machinery, and, owing to the relative absence of these factors from electrical gear, such plant usually has a longer life than hydraulic, steam, or internal-combustion plants, machine tools, and such purely mechanical appliances.

The extent of the useful life of any moving machinery is also influenced by the question of efficiency. Evolution in design and improvement in principles of operation are now so rapid that a machine often ends its useful life long before it is worn out in the ordinary acceptation of the term, as instance some of the older slow-speed reciprocating steam engines by comparison with the modern and efficient turbine plant. In the past, British engineers have been ultra-conservative. What was good enough for my grandfather is good enough for me, used to be their motto when speaking proudly of the performance of some old-time triumph of engineering skill and good quality material which had been doing duty for the last half-century without a falter, but, in the light of modern knowledge, on a most inefficient basis of fuel consumption.

Our American contemporaries, on the other hand, have always marched with the times. They recognised the economy of scrapping plant, often long before its useful life had fairly begun, in order to secure the benefit of the improved efficiency offered by later and more economical designs. It is an undoubted fact that it does not pay to design certain articles for too long a life; progress to-day is so rapid that the additional cost of rugged design and hard-wearing qualities is frequently not justified owing to the rapidity with which the article becomes obsolete. Consideration of these issues leads up to the question of repairs, and raises a very important point in every industry which caters for the needs of the community.

Generally speaking, it is possible to continue repairing any article indefinitely. The ravages of wear and tear can be made good by replacement or relining of worn parts, and in the light of modern possibilities it is not too much to say that there is nothing in the way of a manufactured product which is beyond repair. The repair policy, however, is one which all manufacturers need to formulate very carefully. There are certain unscrupulous firms who look to their repair departments for quite a respectable revenue, seeing in the complex character of their possible charges for this work (always difficult for a customer to challenge) a means towards a very profitable end. Such a policy may pay for a time, but retribution eventually overtakes the transgressor. The honest firm which does not hesitate to advise its clients to "scrap" a really worn-out or obsolete article, even at the risk of losing custom in some few cases, will usually reap its reward in due time.

The same remarks apply to those firms which make a speciality of repair work. It is far better to be frank with a client over a contemplated repair job than to undertake what amounts to a wholesale remodelling of the article submitted, and must necessarily cost the customer as much as, if not more than, he would have to pay for an entirely new and probably more efficient product. A contractor for repairs is often tempted to advise against his better judgment for fear of losing a remunerative contract. He can, however, recoup his

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losses in this direction by acting as agent, on commission, for various firms who specialise in the particular class of goods he lays himself out to execute repairs on. Thus, a man who specialises in overhauling accumulators would hold the agency for several well-known makes of battery, and probably effect a satisfactory sale of a new accumulator where he could not conscientiously recommend the renewal of plates in a badly sulphated specimen.

Street Lighting Economies Needed.

Certain dailies are commenting on the waste of public money entailed by the unnecessary illumination of some of London's main streets, both before and after the necessity exists. For example, it is stated that it is possible to read news print in Hyde Park at least an hour after the main thoroughfares are lighted. Furthermore, complaint is made that some of the more important thoroughfares are lit by central arcs as well as by the conventional line of lamps located along the foot-walks. From observation in various provincial towns the same fault obtains elsewhere. On the other hand, there are still many populous centres which are anything but efficiently illuminated after dark. Efficient illumination of busy streets is the best insurance against accident, to say nothing of crime; and, whilst I should be the last to support profligacy in public lighting, I do think there is need for reform and standardisation in the matter of street lighting throughout the kingdom. Already the classification and sign-posting of our roads is receiving attention along these lines. Why not tackle the street lighting problem on equally common-sense lines? There can be only one "best" way of lighting a given standard of thoroughfare, and it should not be difficult to classify city streets and suburban thoroughfares for uniform and effective lighting.

ELEKTRON.

TELEGRAPHY.

Being Solutions to the Questions set in the Final Examination in Telegraphy held by the City and Guilds of London Institute in April, 1920.

(*Continued from page 193.*)

Q. 4.—A battery produces a current of 300 milliamperes when its terminals are joined by a wire of negligible resistance, and when the battery circuit is completed through a resistance of 1,400 ohms the current is reduced by 80 per cent. Calculate the electromotive force and resistance of the battery.

A.—Suppose E volts is the e.m.f. of the battery, and r ohms is its resistance.

Then, by Ohm's Law, when its terminals are joined by a wire of negligible resistance, we have

$$300 = \frac{E}{r} \therefore E = \frac{3r}{10} \quad \ldots \quad \ldots \quad \ldots \quad (1).$$

When the battery circuit is completed through a resistance of 1,400 ohms the current is reduced to

$$\frac{100 - 80}{100} \times \frac{300}{1000} = \frac{3}{50} \text{ ampere.}$$

Hence in this case $\frac{3}{50} = \frac{E}{r + 1400} \quad \ldots \quad \ldots \quad (2).$

Substituting in (2) the value of E in terms of r given in (1) we have

$$\frac{\frac{3r}{10}}{r + 1400} = \frac{3}{50}$$

$$\therefore r + 1400 = 5r$$

$$\text{or } r = 350 \text{ ohms.}$$

Also from (1) since $E = \frac{3r}{10}$ we have

$$E = \frac{3 \times 350}{10} = 105 \text{ volts.}$$

Q. 5.—What precautions are taken to protect underground lead-covered cables which have been drawn into iron pipes from the effects of chemical and electrolytic action?

A.—The pipes into which underground lead-covered cables are drawn cannot be kept absolutely free from water, and, as such water is usually impure, containing chemical substances in solution, galvanic action is liable to ensue between the lead sheathing and iron pipe. Under these conditions the lead sheathing and iron pipe form a voltaic couple, resulting in the corrosion of the former with attendant insulation difficulties. Obviously it is highly essential to prevent the ingress of water into the pipes, and as this is likely to occur only at the joint boxes, etc., it is necessary to take the precaution of packing all box lids with tarred yarn and a mixture of crane grease and whitening in order to ensure perfect watertightness. Moisture, however, cannot be entirely eliminated, so that to prevent galvanic action large quantities of petroleum jelly are applied to the cables when drawing them into the pipes, thus forming a protective covering.

A very serious source of trouble is that due to the injurious effects of leakage currents from electric light and power circuits. Any stray currents from such sources passing along the pipes, tend to pass through the lead sheathing at the points where the continuity of the pipe lines is broken, as at a joint-box, hence if there is moisture at these points electrolytic action will take place and may be sufficiently great to destroy entirely the lead sheathing there, and seriously impair the insulation of the cable. To prevent this electrolytic action, it is necessary to render the line of pipes electrically continuous at every box or jointing chamber and to connect both the cable sheathing and pipes to good earths at certain intervals. The pipe-sections are connected electrically, or *bonded*, by lead strips, the ends of which are bolted to the ends of the pipes. The ends of the pipes are drilled to receive a ½-in. bolt, and the pipes are laid with their ends projecting 1½ in. into the box. The bonding bolt is lined with lead, it has a hexagon nut, and the washer is recessed to receive the lead-bonding strip. The bonding strip consists of 8-lb. lead, 1 in. wide, and holes are punched into its ends so that they will pass over the bolts and lie in the recessed washers. The top of the pipe with which the lead strip will be in contact is scraped clean, the strip is threaded on the bolt, the washer is put on so that the end of the lead strip lies in the recess, and the nut is tightened up to make good electric connection. Where there are several pipes in a box, the ends of all the pipes and all the cables are connected electrically by means of lead strips.

(*To be continued.*)

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THE WRONG SORT OF MANUFACTURING ENTERPRISE.

Now that the miners are again doing all in their power to force the Government to take over the mines in this country, and other sections of "labour" are urging nationalisation of industry, it is opportune to refer to the utter failure of similar enterprises in another country—not Russia, but a country much nearer to our hearts, Australia. Business men have, of course, known of the experiments in State ownership which have been carried out in that country, but generally our attention has not been directed thereto as is desirable. The scathing criticism of State enterprise in a recent issue of the *Industrial Australian and Mining Standard* is well worth reading. With regard to the canning of fruit N.S.W. and Queensland furnish examples of canneries which are "sinks of public money." True enough, they can a lot of fruit, but the business is a losing one, and the taxpayer has to foot the bill. *The private manufacturer, incidentally, is outrageously abused.* He is obliged, in disposing of his products, to meet the competition of factories that are not required to pay their way, and have the whole resources of the State behind them. He survives partly because of the incomparably superior efficiency of his methods and partly because the State Governments concerned are afraid to exceed a certain limit of extravagance lest they draw upon themselves the destructive indignation of a long swindled and suddenly enlightened public.

The Shepperton Cannery of Victoria represents another wrong sort of factory, viz., the amateur co-operative cannery. It was started by a number of fruit growers who probably knew how to grow fruit very well. What they knew about canning is now becoming evident. They obtained liberal financial backing from the State Government, and they used the public funds advanced them to import a lot of expensive machinery from America, which could and should have been made in Australia. This splendid nation-loving conduct met with its due reward. The Shepperton cannery is already in serious trouble, and finding themselves unable to secure from the State the fresh capital needed to carry on, its managers solemnly proposed last week "*to make it compulsory for suppliers of fruit to take a larger number of shares*" in the concern. It is impossible to sympathise with shareholders in their predicament. Folly is easily pardonable, but not anti-nationalism.

There is a widely prevailing tendency to regard co-operative enterprise as a sure cure for all economic ills, although the would-be co-operators seldom, if ever, have the remotest personal knowledge of the business they propose to establish, but take it cheerfully for granted that the blessed word "co-operation" will surmount every conceivable difficulty. The requisite experience, special skill, technical and administrative talent, they think, can always be bought. "Let us get the right manager and all will be well." Alas, for them, this right manager never materialises, because if he exists he is unpurchasable since he is already doing for himself what they want him to do for them. The only manager available to them is the indifferently qualified person who is incapable of founding a business for himself, and whose services are for sale. He may, perchance, be a good fellow, but the law of life has it that the best manager in the world who is merely a paid servant must inevitably succumb and collapse in competition with the manager who founded, made and owns or partly owns his business. That is why the industrial history of Australia is strewn with the wreckage of bankrupt co-operative enterprises.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 115.

Can any reader give me some information concerning the testing of steam turbines and generators?—"VACUUM."

QUESTION NO. 116.

I would appreciate full constructional details of a resistance which is to reduce 100 volts to 80 volts when a current of 5 amperes is passing for an indefinite period. How shall I wind the wire? Will mica or enamelled insulated steel tubes be satisfactory?; and what size and kind of wire is most suitable if the temperature is not to exceed 300 deg. F.? The resistance is to be enclosed in a flame-proof box, and the use of oil, for cooling, is prohibited.—"B."

(*Replies to Questions Nos. 115 and 116 must be received not later than April 30, 1921.*)

Answers to Questions.

QUESTION NO. 111.

I desire to equip a small test room at the works where I am employed to test meters, motor armatures, etc. Can any reader give me any details of the equipment I shall require for such a purpose? I desire to do testing as applied to a fairly large lighting and power plant. The system is 440 volts, 3-wire.—"ARMATURE."

REPLIES TO QUESTION NO. 111.

The first prize (10s.) has been awarded to "Tester" for the following reply:—

It is difficult to imagine the size of the plant from "Armature's" description, so I propose to describe the requirements of a modern test room for direct current testing, and if it is on too elaborate a scale, the arrangement can easily be cut down to meet his requirements.

The sources of electrical energy in the test room should be as follows:—

(1) A 440-volt power supply and 220-volt lighting supply from the 3-wire supply system at the works, to run the motor-generators, etc., and supply general lighting to the test room. The 440-volt supply cables should be heavy enough to carry sufficient current for the testing of small circuit breakers, etc., when necessary.

(2) Motor generator with an output voltage of about 25 volts for general current work and charging batteries.

(3) Small motor alternator complete with transformer, giving an e.m.f. up to 5,000 volts for flash tests on armatures, etc.

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(4) Heavy current battery of about 3,000 ampere-hours capacity, for heavy current meter, circuit breaker, etc., testing. A convenient number of cells is eight, so that the voltage supplied can either be 4 volts or 8 volts, the cells being joined in series or parallel by means of suitable switchgear. The battery should be fitted outside the test room if at all possible.

All the above sources of supply (with the exception of the alternating current) should be led to separate busbars on a central distributing board.

The A.C. supply should be led direct to the transformer enclosed inside a safety screen, so that the armature to be "flashed" can be placed inside and the high voltage self-contained inside the screen.

From this central distribution board cables can be run, through fuses, to the different benches about the test room; the end of each cable at the board should be flexible with a suitable knife connection fitted to it. Any distributors can then be connected to any of the bars on the board, and thus a supply of any desired voltage taken to any part of the room.

The cables should vary in size according to the current they are desired to carry.

The battery can be charged by simply short-circuiting the motor-generator bars and the battery bars, the motor-generator supply being adjusted to the required voltage.

The testing benches should be arranged as follows:—

(1) Two large heavy tables for the testing of heavy current apparatus such as circuit breakers, starters and controllers. These tables should each be supplied with 2 pairs of cables, one pair to carry up to say 500 amps., and the other pair up to say 10 amps. It is very handy to have two supplies, as in the case of starter testing, for instance. The current used for testing and adjusting the overload can be taken from the battery through the heavy current tables, whilst the hold-on coil can be energised independently from the 440 volt supply through the pressure cables.

(2) A table should be set apart for supply meter testing. This bench should have two supplies as above, and should be fitted up with the usual instruments required for the checking and calibrating of this class of instrument.

(3) Another small table should be reserved for the testing of ammeters and voltmeters. A standard voltmeter covering all necessary ranges should be mounted on this bench against which all voltmeters can be checked. This table should have a small pressure supply from the distribution board and a small current supply direct from the battery. The best way of checking ammeters is to have a standard millivoltmeter fitted, and finding the full load drop in millivolts on the shunt of the ammeter to be tested, check the ammeter (without shunt) against the millivoltmeter. This is a very economical method for instruments being calibrated after repair. The millivolt supply is obtained by taking the drop in voltage over a variable high resistance joined across the battery terminals. The drop on the shunts could be done on either of the benches mentioned at (1).

(4) The usual testing bed for motor testing should be fitted with the necessary arrangements for supply.

(5) A screened area for testing armatures, as before mentioned. The necessary instruments for carrying out the "drop test" on armatures could also be inside this safety screen.

Of course there should be a liberal supply of instruments in a test room. One or two good combined testing sets, and ammeters and voltmeters of varying ranges mounted on portable wooden standards should be available for general use around the test room.

The above is but a brief outline description of the method of lay-out of a typical test room, from which it is hoped "Armature" will find sufficient information to meet his requirements.—"TESTER."

The second prize (5s.) has been awarded to Mr. Philpott, 51, Leonard Road, Handsworth, Birmingham, for the following reply:—

In such an installation as mentioned in this question, it is generally necessary to carry out the following tests:—

(1) *General Tests.*—The three-wire leads should be brought into the room to two slate switchboards—one for 440 volts and the other for 220 volts. Each of these should have a D.P. switch, a pair of fuses and one or more pairs of terminals to which the testing leads are connected.

For general circuit tests the usual requirements are: (*a*) two voltmeters 0-500 and 0-10 volts. These should be of the moving coil type (unless alternating current measurements are contemplated) and of a good make. (*b*) Two ammeters 0-100 and 0-10, or one instrument with a variable shunt. (*c*) An assortment of switches, resistances, wire, etc.

(2) *Continuity Tests* may be made either with the 220 volt mains through a lamp, or by means of an accumulator and detector-galvanometer. The latter method is recommended.

(3) *Resistance* is best determined by the use of a "Post Office Box," although approximate readings may be made by using a voltmeter and ammeter, and calculating the result by Ohm's Law.

(4) *Insulation Resistance* is measured with a "Megger" or similar instrument.

(5) *Motor Testing.*—In addition to apparatus already mentioned, a few starters of various sizes will be required. Old ones rewound will do, or they may be borrowed from stock as required.

(6) *Armatures* are usually tested for "shorts," etc., by means of the volt-drop test, for which an accumulator, rheostat and central zero millivoltmeter, are required. A useful range is —500 to +500 millivolts.

(7) *Earths and Insulation Faults* are detected by subjecting them to a high-tension test (or "flash test"). The necessary voltage is generally obtained by the use of a small rotary converter and transformer. A variable rheostat in the armature circuit, a voltmeter across the secondary terminals of the transformer, and the usual starting gear, complete the equipment. The secondary voltage may normally be about 2,000 volts, but, of course, can be varied by the adjustable rheostat.

(8) An accumulator charging panel is a very necessary item in the equipment of a test room (especially where operators have electric bicycle lamps!).

If there is only a small amount of work to be done, the accumulators may be charged from the 220 volt mains, through a lamp or wire resistance and an ammeter. This is obviously a very inefficient method and it is much better to put in a 440 volt motor-generator set (about ½ K.W.). The generator should have a variable resistance in its field, the normal voltage being about twenty. Besides being used for charging, this set would be useful for plating or boosting if required.

For general testing work, a 12 volt 100 A.H. accumulator and a small one (4 volt 40 A.H.) are useful.

(9) *Voltmeters and Ammeters* are generally checked by comparison with instruments known to be accurate.

Of course, if accurate calibration is required, it will be necessary to obtain a potentiometer set.

Books.—A reader wants to sell a set of "Modern Electrical Engineering," by Maclean. See a small advt.

Meetings.—The Annual General Meeting of the members of the Electrical Trades Benevolent Institution, will be held at 2.30 p.m. on Monday, April 25th, at the offices of the Cable Makers' Association, Sardinia House, Sardinia Street, W.C.2, to receive the report of the Committee of Management, and to pass the accounts and balance sheet, also to consider proposed alterations in the Rules.——The next informal meeting of the Inst.E.E. will be on Monday, 11th inst., at the Chartered Institute of Patent Agents, at 7 p.m. (Staple Inn Buildings, Holborn, W.C. Discussion on "Some Characteristics and Applications of Multispeed A.C. Motors"; to be opened by Mr. F. Creedy.

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GLASS LAMP-BULBS.

FOURTEEN FACTORIES TO CLOSE ON SATURDAY.

Great disappointment is felt in the glass industry that, although the proposals of the Government for the protection of key industries include optical and scientific glassware, glass lamp-bulbs are omitted from the schedule. This branch of the industry has been so undermined by German competition that the fourteen manufacturers have given notices to their 6,000 workmen, and have decided to close their factories next Saturday. One of the factories is at Walthamstow, and the others are in the Midlands and in the North. The Chemical Ware Manufacturers' Association states that it will be impossible to reopen them unless they are safeguarded as a key industry. An effort is to be made in Parliament when the Ways and Means resolutions are discussed to get reconsideration of the claims of the industry.

The output of glass bulbs has been rapidly expanded to 1,000,000 per week, and the price of the British-made article is 1½d. to 2d. each. During the war labour was specially trained for what was then an entirely new manufacture, and the fact that glass bulbs were always regarded by the Government as an essential key industry and were included in the Imports and Exports Regulation Bill makes the present attitude of the Government all the more surprising.—*The Times*, April 5, 1921.

A NEW PUBLICATION ON STEAM TURBINES.

Recent developments in turbo-electric units by the English Electric Co., Ltd., show that machines of capacities between 10,000 k.w. and 30,000 k.w. can be built. Thus the company's range of complete units is from 250 k.w. up to 30,000 k.w. Both Impulse and Reaction types are manufactured, but for turbines within the range of standard sizes at present considered practicable, the Impulse type has many advantages, though for large outputs it is not impossible that development will incline towards the use of the Reaction principle for the low pressure expansions on account of its special suitability for dealing with the larger volumes of low pressure steam involved. The range of standard sizes of E.E. turbines is as follows :—

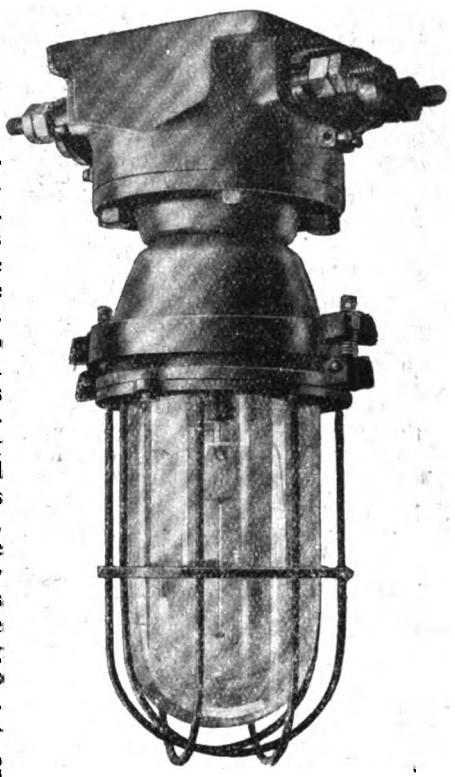
Speed	5,000	3,000	1,500 R.P.M.
Range	250/1,000	500/12,000	5,000/30,000 K.W.

A new publication (running to 52 pp.) issued by the company describes the essential features of their standard Impulse type turbines in detail, numerous illustrations and sectional drawings being given. Useful features are a diagram and list of overall dimensions for a complete range of turbo-generators, and a large coloured sheet showing the arrangement of a generating station containing two 10,000 k.w. turbo-alternators being supplied to the order of a municipality in this country. A long list of turbo-generators in operation or on order further supplies evidence of the magnitude of the company's operations in this field. In addition, back pressure, low pressure, mixed pressure and reducing turbines are manufactured.

The publication is numbered No. 225, and is titled "Steam Turbines (Section 1)," and the company's head office address is Queen's House, Kingsway, W.C.2, and the works it will no doubt be remembered are at Preston, Coventry, Bradford, Stafford and Rugby.

THE SIMPLEX COLLIERY LIGHTING SYSTEM.

A range of flame-proof and water-tight lighting boxes and fittings, designed to comply with the latest regulations governing the use of electricity in mines is being put on the market by Simplex Conduits, Ltd. (Garrison Lane, Birmingham). A general feature is the interchangeability of the component parts (which are reduced to a minimum), while the boxes are fitted with "easy wiring" interiors and have clamping and binding glands for use in conjunction with single wire armoured twin V.I.R. cables up to 7/.036.



The cable glands are of the cone type, in which the armouring of the cable is secured between a malleable iron clamp and the outer surface of a brass cone, which is bored to receive the core of the cable. The brass cone is seated into the box, and a rubber gasket is interposed to ensure the joint being gas-tight and water-tight. This gasket, however, does not interfere with the continuity of the system, as each brass cone has a bonding lug provided with two cheese-head screws. An alternative design of brass cone, internally threaded to receive a brass bush and rubber packing ring, can be supplied. The bush and cone are bored out to the diameter of the core of the cable; on tightening the bush, the packing ring is firmly compressed on to the cable core. The method of making connections is a special feature of the Simplex colliery box. The brass connecting pieces, although readily detachable, are rigidly clamped between insulating bushes nesting together on a central stud.

The illustration shows a fitting intended for H.V. vacuum type lamps up to 60 watts and explains itself, the only remark at all necessary being that the details are most satisfactorily worked out. By the simple expedient of turning the box through 90 degrees and attaching a right angle arm, a bracket lantern and box is obtained, in which the projection from the wall is less than with a bulk-head fitting.

By the provision of large radiating fins on the lantern top and other necessary modifications, a colliery lantern

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and box suitable for H.V. gas-filled lamps up to 100 watts or two vacuum type lamps of 60 watts each has been evolved. From a series of tests with a 100 watt gasfilled lamp the maximum temperature rise within the box has been found to be under 40° F.

A booklet describing and illustrating the system will be sent by the Simplex Co. to any electrician, particularly mining electrician, who asks for one.

VOLTAGE REGULATION.

Electric energy, whether for use in traction, lighting or power systems, is usually at, or nearly, constant pressure, whatever the load, and consequently the current, may be. This is not invariably true. A constant-current, varying-voltage system may be employed—as, for example, in high-tension transmission, and occasionally in arc lighting—the presure in volts being made to suit load conditions.

In the former case a very close voltage regulation is necessary in incandescent lighting, whether the lamps have carbon or metal filaments. "Steady light demands steady voltage" may be accepted as a proposition to be adhered to. Not only so, but the life of a lamp is very much redueed when the voltage varies even within narrow limits, more especially in the first-named lamp.

Taking 100 as our unit for normal voltage, candle-power and life respectively, and expressing the changes in terms of this, it has been found that when the voltage falls to 90, the candle-power falls to 50; when it rises to 110, the candle-power rises to 190 and the life falls to 50. These are, of course, extreme limits, but it serves to show the great rate of rise and fall in candle-power, and the great fall in life when the lamp is "over-run."

To take a real case in a lighting circuit for a voltage of 102, two above normal, the candle-power is increased by 11 per cent., and the life reduced by 35 per cent. A voltage of 101 gives 6 per cent. more light with a 20 per cent. reduction in life. Conversely, when the voltage falls below 100, the candle-power falls above five times as rapidly. It is evident, therefore, that close voltage must be adopted in all lighting circuits.

The position is not nearly so bad in a power or traction circuit. The worst that can happen is that, with a rise in voltage, the motors will run faster or the train or speed will speed up with a given load. When the voltage falls the opposite will happen. Unless close-speed limits are necessary, the Board of Trade specify that a range of 5 up and 5 down are allowable; for a lighting circuit, 2 up and 2 down.

Voltage Variation (i).—In *generators* driven by a steam engine, the speed variation under varying loads and changes in the mean effective pressure of the steam cause a change in voltage. Where water-power is used as a prime mover, a source of varying voltage is the slow operation of the governors and changes in the head of water; and, lastly, with oil or gas engines there are voltage fluctuations caused by differences in the quality of the oil or gas and changes in the frequency of the firing stroke.

(ii) *Temperature Changes.*—When the generator starts on a load the windings on armature and field are cool, and the resistances which these have are expressed at 60 deg. F., or the temperature of the dynamo room. Although well ventilated, the machine warms up, and these resistances rise with the temperature. This gives a larger voltage (*CR*) drop in the armature. There is, therefore, less voltage available to send current round the field coils. Thus the field is weakened; and, not only so, the increase in resistance of these field windings still further lowers the current, and this process goes on until the temperature ceases to rise. These factors, therefore, operate to make the terminal *PD* less than it would be at the lower temperature.

(iii) *Loss in Feeder Circuits.*—In the case of an electric railway or tramway, the loss of voltage will be due to the loss in the outward copper conductor and the return iron rail, and in a power or lighting circuit there will be two or three conductors, outward and return. As in the case of the generator, the drop will be determined by *CR*—i.e., to the current passing and the resistance encountered—the terminal *PD* being reduced by this amount, the value of *C* depending on the load, and that of *R* depending on that of the conductor from the generating station.

(iv) *Variable Loads.*—The greater the load the greater the voltage loss, so that, for a given load, when the voltage is correct at a distributing point, a new adjustment must be made for a new load. For instance, we may have *sudden and irregular loading*, as in starting and stopping large motors, or *slow and gradual loading*, as in adding lamps in the early part of the evening. It is well to remember that, in the latter case, these slow rises increase and slow falls reduce the brilliancy of the light, and voltage rises reduce the life of the lamps, as has been already pointed out.

With sudden motor loads they cannot be followed quickly enough at the switchboard, and it is usual to have a suitable voltage regulation arrangement on the busbars or feeders.

AN IMPROVED ELECTRIC VEHICLE BATTERY.

The D.P. Battery Co., Ltd. (11, Victoria Street, S.W.1), have put on the market for use in electric vehicles a battery for which it is claimed that the cells never have to be cleaned out. This claim, it is said, has been substantiated, and a report on an excellent performance is given later in this article.

Further, it is stated that the "D.P." vehicle cells will stand up to the excessive charging and discharging that may be experienced in the worst of garages, and at the same time the plates are of high capacity—separators, of a special material, designed and applied so that the active material cannot fall away from the plates being used. As a result, the deleterious effects incidental to the periodical removal of sediment are eliminated, and the watt-hour capacity of the cells is the highest per lb. of battery.

The following is an unsolicited testimonial from the British Elec. Vehicle Co., of Southport, to the D.P. Co.:—

"With reference to the battery* which you supplied to us for test on our electric car, we have now been running this car for some little time, and yesterday had a trial run of 80 miles.

*42 "TR" 13 Type "D.P." cells, having a rated capacity 145 ampere-hours at the 5-hour rate of discharge.

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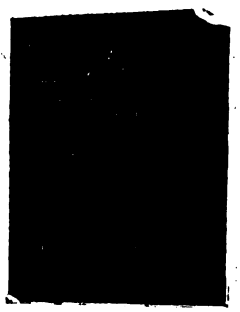
"We started with a gravity of 1265, took out of the battery 110 amp. hrs., gravity on arrival 1200, distance covered 40 miles. The battery was put on charge at a constant voltage rate of 110, and at the start of the charge 40 amps. was passing. The charge was continued for three hours, and at the finish the voltage was still 110, and the amps. had tapered down to 20. We then started on the return trip, using 100 amp. hrs. The gravity of the cells when we started was 1250, and the gravity at the finish, after doing 40 miles, was 1175.

"We think these figures might be of interest to you, and are somewhat in the way of a record for an electric car on a long-distance run. We may mention we did the first 40 miles in 2 hr. 15 min., there being a very strong head wind for the last 20 miles. On the return trip, which was done in the evening, the wind was behind us to start with, but gradually died away."

HART ACCUMULATOR CO., LTD.

New Catalogue.

The 1921 edition of the storage battery catalogue, issued by the Hart Accumulator Co., Ltd. (Marshgate Lane, Stratford, E15), is a handsome production, tastefully designed yet impressive, well printed, fully indexed, alphabetical and thumb. Secondary cells are



described, and full particulars and prices given for all kinds of work, from the smallest to the largest. Included are the Hart "Safety" ignition batteries (non-inflammable, the boxes being made of composition similar in appearance to ebonite, but stronger, while the plates are suspended in tension from ledges moulded in the sides of the box—thus bottom supports are not necessary), and high-tension batteries for wireless, testing, etc. Accessories also are listed, and general information of interest and value included.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

Science German Course. 3rd edition. By G. W. Paget Moffatt. 270 pp. (University Tutorial Press. 5s. net.) This book, which has already an enviable reputation in this country, deserves to be yet more widely known, for it is undoubtedly exactly what is wanted by innumerable students and engineers. The book contains enough of the accidence and syntax to meet all the requirements of the beginner who wishes to be able to read German technical literature in any field, but the book will perhaps be most appreciated by those who "took German" at school, and who did not flourish exceedingly in the subject. Now that they have arrived at years of discretion, many such persons wish that they could read technical German, but they have not the time and opportunity to wade through an ordinary German grammar. Indeed, such a treatise often proves to them as much a hindrance as a help. The special needs of such men are met completely by the present work, which gives a brief and very clear treatment of grammar and the formation, arrangement and use of German words and sentences. In addition, and to many readers this will be the most valuable portion of the book, there are carefully selected extracts for reading. These extracts have been selected to include as many technical terms as possible, and they deal with mathematics, physics, chemistry, geology, botany, and zoology. Most of the requirements of the engineering student are covered by these various extracts, but in the next edition we should like to see a few more extracts taken from engineering literature. The book concludes with a sixty page vocabulary, which in itself constitutes quite a useful technical dictionary.

Coal Saving in the Chemical Industry. By D. Brownlie. 150 pp. (Brownlie and Green, Ltd. 2s. 6d. net.) The author has had a most extensive experience in boiler testing and combustion engineering generally, and in this publication he presents some of the results which he has obtained. It is safe to say that such a collection of reliable data is obtainable nowhere else. In this particular report, the author deals with the results of investigations on the boiler plants of sixty different chemical works in Great Britain. The importance of the report may be judged from the fact that the net working thermal efficiency of these plants is only about 58 per cent., whereas it could quite easily be about 72½ per cent. The difference represents a most serious national loss in coal in this one industry alone. It is high time that all steam-using industries realised that expenditure on staff and equipment for the maintenance of highest thermal efficiency is a most profitable investment. From the national point of view, this investment should be made compulsory. The principal sources of inefficiency and the means whereby they may be avoided, are explained in this publication.

Diesel Engine Design. By H. F. P. Purday. 301 pp., 271 figs. (Constable. 21s. net.) This book is intended primarily for designers and draughtsmen, and is based upon 12 years' experience in design. Naturally it is also most useful to technical students, and contains a great deal to interest users of Diesel engines. Within small compass, it is difficult adequately to review a single-purpose book of this kind, the scope of which is necessarily well defined. The general scheme of the book is that a separate chapter is given to each of the main components of the engine. In addition there are introductory chapters dealing with first principles, thermal efficiency, exhaust, suction, and scavenge, and the principle of similitude as applied to Diesel engine design. The fuel oil system, the air and exhaust system, the compressed air system, and the valve gear each receive detailed consideration. The text deals mainly with general principles as exemplified by examples of good modern practice. Within the limitations of space all modern practice is well described, but it has not been possible to deal with every constructional novelty, neither has it been considered desirable to give detailed treatment of the stepped piston and opposed piston types of engine. The book is clearly written and entirely free from padding. It is well and liberally illustrated, and may justly be regarded as an authoritative work which should be studied by all interested in the design and use of Diesel engines. It is only fair to say that the book is not intended for the ordinary operator of Diesel engines, but such men are generally "keen in their vocation," and we believe that a majority of them would read this book with interest and profit. To those for whom the book is primarily intended, it is, of course, indispensable.

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Various Items.

Faraday House Old Students' Dinner.—The annual dinner will be held at the Holborn Restaurant on the 15th inst., at 6.30, with Mr. C. C. Paterson, O.B.E., M.Inst.C.E., F.Inst.P., M.I.E.E., in the Chair. An excellent musical entertainment is promised.

Personal.—Messrs. H. W. Smith & Co. (1920 Ltd.), electric wire and cable manufacturers, of Central House, Kingsway, London, W.C.2., have appointed Mr. W. J. Davies, Dydraw, Porthcawl, as their representative for South Wales. His Telephone No. is 65 Porthcawl.

Now Ready.—The 1921 edition of Kempe's Engineers' Year Book is now ready, and any reader who wants a copy ought to order it at once from Messrs. Rentell (Electricity Office), 36, Maiden Lane, London, W.C.2. The edition is limited, and as it is up-to-date in every respect it is a really invaluable work of reference. Price, 30s. net.

The Metropolitan-Vickers Calendar.—Our Manchester friends have just sent us their Almanac for the twelve months from April, 1921, to March, 1922, and it is, as usual, a very charming and artistic platinotype of a lady who is undoubtedly one of the types of English beauty for which this country is renowned. It is sure to be appreciated by all who are fortunate enough to receive it.

Tenders Invited.—H.M. Trade Commissioner in New Zealand has forwarded to the Department of Overseas Trade particulars of a call for tenders by the Public Works Department for the supply and delivery at Lyttelton of 2,000 pin insulators suitable for a line operating at 66,000 volts (Section 107). Tenders, which must be accompanied by a deposit of £100, will be received up to noon on April 19, by the Secretary, Public Works Tenders' Board, Government Buildings, Wellington. The Department is also asking for quotations, to be submitted by April 19, for the supply of 400 Strings of Strain Insulators complete with the necessary hardware for use on a 66,000 volt, three phase, transmission line. Specifications may be seen on application to the Department of Overseas Trade (Room 59), 35, Old Queen Street, Westminster, S.W.1.

Obituary.—March 31, was a sad date for our esteemed contemporary, the "Electrical Review," as on that day Mr. Tom Ernest Gatehouse, who had been editorial and technical director almost from its very beginning, passed peacefully to his rest after a short illness. Mr. Gatehouse was indeed one of the finest type of an English gentleman, always cheery and good-hearted, and he well maintained the high traditions which have been associated with the editorial columns of the "Electrical Review" from its inception. He was also the vital centre and prime mover in the Electro-Harmonic Society, which he helped to found 35 years ago, and his loss is one which will create a very sad gap in the electrical profession in Great Britain. The writer knew him from the early days of 1886, and has vivid recollections of his kindly assistance and advice in the time when Electricity was young and struggling, and therefore feels his death as a real personal loss. At the funeral at Norwood Cemetery, on the 5th inst., many old friends were at the graveside to pay the last tribute of respect to one who was a real friend to all, and we can but express our deep sympathy with his family circle.

Meetings.—The next Monthly Meeting of the Birmingham and District Electric Club will be held at the Grand Hotel, Colmore Row, on Saturday, April 9th, at 7 p.m. prompt. Paper: "Supply of Electrical Energy in Birmingham and District," by Mr. Frank Forrest, M.I.E.E.——The Inst. E.E. will meet at the Inst. C. E., Great George Street, Westminster, S.W., on Thursday, 14th inst., at 6 p.m. Paper: "Magnetos for Ignition Purposes in Internal Combustion Engines," by E. A. Watson. ——The Junior Inst. of Engineers, will meet on Friday 8th inst., at Caxton Hall, at 8 p.m., Questions and General Discussion. Also on Friday 15th inst., at Caxton Hall, at 8 p.m., Ordinary meeting. "The Metering of Steam," by C. R. Sams, Assoc. I.M.M. (Member). Slides.; And on Friday, 22nd inst., at Caxton Hall, at 8 p.m., Lecturette "Construction and working of Marine Water-tight Doors," by H. P. H. Anderson (Member). Slides.——The Association of Engineers-in-Charge will meet at St. Bride's Institute, Bride Lane, Fleet Street, E.C.4, on Wednesday, 13th inst., at 7.30 p.m. prompt, when a Paper will be read by A. Arnold, A.M.I.Mech.E. (Member), on "Oil and Colloidal Fuel."

Meetings.—The Sixth Ordinary and Annual General Meeting of the Scottish Centre of the Inst. E. E. will be held at the Rooms, 207, Bath Street, Glasgow, on Tuesday, 12th inst., at 7.30 p.m., when a lecture will be delivered by Major Jas. Erskine Murray on "The Uses of Wireless Past and Future" with lantern slides and some experiments.——The Seventh Ordinary Meeting of the Scottish Centre will be held at 7.30 p.m., on Friday, 29th inst., at Technical Institute (Electrical Engineering Lecture Room), Dundee when a Paper by Messrs. E. Griffiths, D.Sc. and F. H. Schofield, B.A., B.Sc., entitled, "Some Thermal Characteristics of Electric Ovens and Hot-plates," will be read.

Darwen.—The Electricity Commissioners have approved of the loan by the Town Council of £15,524 in respect of various transformers and apparatus for the supply of current from the neighbouring town of Blackburn.

Service Notes.—It is intimated that full accountant responsibilities are to be taken over by officers in charge of Wireless Stations at Malta and Ceylon, including the payment of personnel.

Concert.—The Finsbury Technical College Old Students' Association will hold a Smoking Concert at Anderton's Hotel, Fleet Street, E.C., on Friday, 22nd inst. The Chair will be taken by the president, Professor G. T. Morgan, O.B.E., D.Sc., F.R.S., at 8 p.m. Mr. L. M. Clark, A.I.C., has kindly undertaken the arrangement of the musical programme. Early application for tickets (price 2s. 6d. each) should be made to H. P. Guy, Hon. Secretary 209, Northumberland Park, N.17. Morning Dress.

Burnley.—The Electricity Department has barely three weeks supply of coal. The Tramways Manager is applying for suspension of the National Transport Workers' Agreement, so far as it relates to a guaranteed week for tramway servants.

Freemasonry.—At the regular meeting of the Kelvin Lodge, which was held at the Connaught Rooms on Thursday 31st ult., the reigning Master, Mr. H. Porter-Cox, presided over an assembly of 87 members and visitors including many men well-known in the electrical profession, and during the course of the various speeches which were made at the banquet following the Masonic ceremonies, he referred to the fact that in the course of the next few weeks he was due to be installed in the Chair of the Kelvin Chapter and would then be occupying simultaneously the Chairs in both the Lodge and the Chapter, an occurrence which it was quite likely would never occur again. He felt the honour and responsibility of his position, but at the same time expressed his keen appreciation of the way in which he had been supported by the members in connection with the Great Masonic charities and also referred to the rapid growth of the Lodge during the last few years, which showed the interest taken in the craft by the electrical engineering profession, and the desire of so many of those who were associated therewith to become members of the Lodge. Much regret was expressed at the absence through illness or other unavoidable causes of various well-known friends, with whom he felt certain those present had every sympathy. Altogether a very happy evening.

The Edison Swan Electric Co., Ltd. (Ponders End, Middlesex), has issued a folder drawing attention to the Ediswan Acme Accumulators, in which the plates are of patented design to ensure high capacity.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
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APRIL 15, 1921.

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THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

By Sir William Noble, M.I.E.E.

(*Continued from page* 198.)

The earliest underground cables used in the long-distance telephone system were of the same type as those used up to that time in the telegraph service for subterranean lines. They were made up with copper conductors weighing 40 lb. to the mile, covered with 50 lb. of gutta-percha to an overall diameter of 174 mils. For telephone purposes these covered wires were laid up in quad formation around a jute core with an outer wrapping of tarred tape, the circuits being formed on the diagonals. These cables gave circuits with the following constants (per mile of loop):

R=44 ohms
C=0.2 microfarad
L=1.5 millihenrys
Insulation=1.000 megohms

Attenuation constant= 0.12 at 800 cycles per second.

The inefficiency of transmission of these cables restricted their use in the telephone trunk lines to the terminal sections in large cities, and to the leading in at testing points.

Rubber-insulated conductors were also used to a very limited extent, but were found to give less satisfactory results in practice than the gutta-percha cables.

The introduction of air-space cables with paper insulation and lead sheathing in the early nineties of last century appeared to offer a solution of the difficulty in carrying telephone circuits underground, although the first practical experiments with this type of cable were somewhat discouraging. Numerous breakdowns of underground air-space paper cable sections occurred, and until the causes had been discovered and proper remedies found, maintenance engineers were very reluctant to replace their old gutta-percha cables with the air-space type.

Apart from questions of workmanship in drawing in and jointing underground cables, the comparison between the two types was narrowed down to their respective susceptibilities to damage by lightning, and in this respect the gutta-percha cables appeared to hold a distinct advantage.

Short sections of underground cables connected with long lengths of highly-insulated aerial wires form effective spark gaps for lighting discharges unless very efficient protectors are installed at the ends of the cable sections. At the time of the introduction of air-space cables into the telephone trunk system, the standard type of lightning protector for underground sections was a small vacuum tube with platinum electrodes (Fig. 1). These tubes were mounted in teak weatherproof cases fixed on the terminal poles at the junctions of cable and aerial line sections. The tubes were exhausted to a vacuum of about 2 mm. of mercury. In spite of regulations for the frequent testing of these tubes, especially after thunderstorms, faults in underground cable sections caused by lightning were numerous: but whereas in the case of gutta-percha cables the fault would be limited to perhaps one or two circuits only, in the case of air-space cables the lead sheath was melted and sooner or later moisture entered and the whole of the circuits in the cable were stopped. The replacement of the faulty gutta-percha cable was a comparatively easy and speedy matter, whereas the repair of the air-space cable was frequently a difficult and tedious operation entailing a considerable loss of revenue-earning time on the circuits involved. Considerable experience had already been obtained in the use of air-space underground cables for short telephone circuits in city areas, and their superiority over gutta-percha cables for this class of service had been proved. Damage by lightning was unknown in the case of wholly underground circuits. The design of a more efficient lightning protector for trunk cable sections and improved workmanship in handling and jointing lead-sheathed cables soon established the air-space cable for trunk-line purposes, and at the end of the last century gutta-percha subterranean telephone cables were obsolescent, all renewals being effected with air-space cables.

The superior transmission efficiency of the air-space cable, and the fact that much heavier conductors could be used as compared with gutta-percha cables, permitted longer underground sections in the trunk routes, and so afforded a solution (although only a partial one) of the increasing difficulty in carrying heavy main routes through urban areas and into the main terminal towns: but with the extended lengths of underground sections, a fresh difficulty, which had not been apparent in gutta-percha cables, cropped up, namely, increased cross-talk between adjacent circuits.

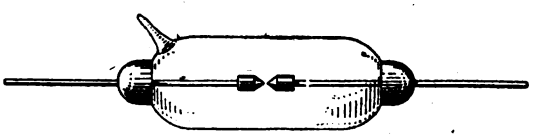


Fig. 1.—Vacuum-Tube Lightning Protector.

In the gutta-percha cables the mean distance between loop circuits and the comparatively short lengths of underground sections were such as not to increase perceptibly the mutual disturbance between neighbouring circuits; but the close packing of the conductors of the air-space cables and the increasing length of cable sections introduced conditions of mutual disturbance which had serious effect on the commercial efficiency of the long-distance circuits.

At the outset this limit to the use of air-space cables for long-distance telephone circuits appeared almost insuperable, but in view of the importance of a solution of this problem, special attention was given to it by Post Office engineers.

Messrs. F. Tremain and A. W. Martin, between July and October, 1899, made an exhaustive investigation of the electrical properties of a 93-mile section between London and Leamington of the first London-Birmingham air-space underground cable.

This investigation had for its principal object a comparison of the telephonic cross-talk between telephone circuits and inductive disturbances between telegraph circuits in the two types of construction used in this section of cable. This section was made up, broadly speaking, of 28⅓ miles of quadruple-core formation from Cricklewood to Eddlesboro', the remainder of the section being made up of wires twisted in pairs. Although every effort was made by the cable manufacturers to produce symmetrical cable with the view of minimising cross-talk it was found that speech telephonically transmitted over a loop made up

*Paper read recently before the Inst.E.E.

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of diagonal wires in a given core of the quadruple formation could be heard in a telephone joined to the other pair of wires in the same core; but between diagonal pairs of neighbouring cores, no such cross-talk was observed in the 28½-mile section tested. This result was attributed to the distortation of the quadruple core, and it was then concluded that the defect in this type of air-space cable was too difficult, if not impossible, to remedy in the course of manufacture. Attention was then directed to the cross-talk observed between neighbouring loops in the pair-type formation, and it was found that the cross-talk was practically negligible between two circuits of 52 miles in length when these circuits did not run for more than 5¼ miles in adjacent pairs. The ratio, i.e., 10 per cent. of length of adjacent wires to length of the whole circuits, was considered significant and was used as a guide later in the investigation for arranging crosses to eliminate or reduce cross-talk disturbances.

The investigators found in their experiments with the 28 miles of quad-core cable that they could eliminate cross-talk between the two circuits carried by a quad-core by making crosses of individual wires, and pairs of wires, at six intermediate points in the 28-mile section. They employed seven distinct varieties of crosses, namely, crosses A, B, and C, in which the individual wires in either or both pairs are crossed; cross D, in which one pair of wires is crossed with the other pair; and crosses E, F and G in which the pairs themselves are crossed in addition to the individual wires of one or both pairs. This systematic method of crossing exhausted the possible number of crosses which could be made in joining up the four wires of a quad-core. Messrs. Tremain and Martin have pointed out that 42 possible single crosses could be made at the six intermediate crossing points without making a cross from one core to another. By making a total of 650 crosses, of individual wires and pairs at the intermediate crossing points, they succeeded in making this 28-mile section free from telephonic overhearing or cross-talk without necessitating any crossing of cores, a consideration which, at that time, was of some practical value. The investigation of cross-talk in the pair-type formation indicated that no appreciable cross-talk would occur when crosses of pairs were made at intermediate crossing points, to ensure that no two pairs of wires remained parallel and adjacent for more than 10 per cent. of the total length of the circuit. At a subsequent date a systematic method of balancing by crossing cores wrapped with paper of different colours was adopted in order to satisfy this condition. The balance obtained by this method of crossing proved so effective that the telephone loops in the central portion of the cable were not seriously interfered with by single-wire telegraphs in the outside layer, nor vice versa. It was also observed that a key-speed telegraph circuit worked on a loop did not interfere with the telephone circuit in an adjacent loop. Even Wheatstone working on a loop did not interfere with the telephone circuit, provided one pair of wires was interposed between the two circuits. It was further reported in this experiment that so long as the rule was observed that no two pairs of wires were parallel and adjacent for more than 10 per cent. of the whole length of the cable, loops could be used indiscriminately for telephone or telegraph circuits.

It may be mentioned that before these results were obtained the investigators found it necessary to measure the electrostatic capacity of every wire in every section of the cable, and, similarly, measurements of copper resistance were made to the highest accuracy obtainable with the apparatus then available, the figures being recorded to 1 in approximately 10,000 parts for capacity, and 1 in 5,000 parts for resistance.

The jointing procedure adopted as the result of the foregoing experiments fulfilled all requirements of the Post Office, until the method of improving the efficiency of telephone circuits by inserting inductance coils was adopted. The placing of loaded telephone circuits in the underground cables necessitated a reconsideration of the practice of providing telegraph and telephone circuits in the same cables, owing to the fact that loaded circuits, whilst being more efficient than unloaded ones, are at the same time more susceptible to inductive disturbance. Experiments showed that Wheatstone circuits on single wires caused serious disturbance to loaded telephone circuits in the same cable, and in some cases marked induction had been experienced on such circuits from Wheatstone circuits worked on loops. In consequence of these difficulties it became necessary for a time to provide separate cables for telegraph and telephone purposes. As the trunk underground system grew it was found uneconomical to provide separate cables for the two services, and special efforts had to be made to overcome the difficulties experienced. The method of superposing loaded telephone circuits on other telephone circuits already loaded was also found impracticable with the same degree of balance in the conductors which was found sufficient for unloaded circuits. In 1912 it was found with the usual method of cable construction that the practice of placing telegraph circuits in the same cable as loaded telephone circuits would have to be abandoned, and that phantom loaded telephone circuits could not be successfully superposed upon loaded physical telephone circuits without improving the symmetry of the conductors in underground cables or improving the balance of conductors by selective jointing.

As a consequence of the difficulties experienced, the whole question of cable design and balancing by selection of conductors for jointing was taken in hand afresh by the Research staff of the Post Office. Early in January, 1913, Mr. Pollock initiated an investigation of the relation which existed between cross-talk and wire and wire, and wire and earth capacities in quad-core and multiple twin cables when tested in short lengths, and devised apparatus for making the capacity measurements with alternating current of telephone frequency with the necessary degree of convenience and accuracy. Short lengths of cable were specially constructed with a great variety of different lays in the paired conductors, and it was shown that whilst certain selected lays gave favourable experimental results, the necessary symmetry in the spacing of conductors could not be obtained by cable manufacturers to ensure a sufficiently good balance of the various capacities between conductors and between conductors and earth. An approximate formula was obtained for connecting the amount of cross-talk between circuits in the cable with the capacity relations of the conductors, and a systematic method was worked out by which the unbalances of capacity in one short length could be greatly reduced by selecting wires in contiguous lengths having nearly equal and opposite characteristics, so that the conductors when joined together would neutralise each other's defects. This plan only differed in degree and detail, but not in principle, from the method of balancing previously adopted by Messrs. Tremain and Martin. In order to obtain the required degree of balance for loaded and superposed circuits it was found necessary to test every drum of cable of approximately 176 yards in length, instead of sections of approximately 5 miles, and pre-select the wires for jointing at every 176 yards by inserting crosses as between core and core, in addition to crosses as between individual wires and pairs. The system of testing and selection is necessarily laborious and complex, and a number of the most able officers in the Research Section of the Post Office have contributed most valuable improvements, both to the mathematical theory and to the practical methods of cable balancing.

(To be continued.)

The Bridges Tent Frame is a new and improved type of Jointers' tent frame made by **British Insulated and Helsby Cables, Ltd.** (Prescot, Lancs.), under Pat. No. 150936. It is light, strong, amply braced, and folds into small compass for transport. The roof is of span construction and takes an ordinary tarpaulin

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MOTOR-CAR HEADLIGHTS: IDEAL REQUIREMENTS AND PRACTICAL SOLUTIONS.

A paper on the above subject was read by Major A. Garrard before the Illuminating Engineering Society on March 17, Mr. Worby Beaumont presiding.

Major Garrard pointed out the great importance of a really satisfactory headlight in view of the increasing speed of traffic and the probability that motor vehicles will be used in this country to an even greater extent in the future. A fully satisfactory headlight should be such as to enable a driver to detect an object ahead at a sufficient distance, and to pull up or change his course or speed as occasion requires, and the driver should also be able to see enough of objects off his direct line of vision and progress (e.g., hedges, ditches, etc.). At the same time other road users should not be seriously inconvenienced by the brightness of the beam.

The great difficulty lies in reconciling these two requirements. An ideal solution would be the choice of a colour or quality of light which would reveal distant objects without causing dazzle. Hitherto, however, there has been no material advance in this direction. Yellow glass gives a beam which is said to be effective in a fog but has little effect in minimising glare. The use of coloured spectacles or coloured glass on the windscreen has the objection that while it diminishes the glare of opposing headlights it also interferes with the vision of the driver, so far as distant objects are concerned. The only practical method, therefore, is one based on method of distributing the light.

This last problem was discussed by the lecturer in great detail. He dismissed methods involving the obscuring of the faces of headlights by diffusing substances, or small lens-projections, as such devices merely scatter the light, reducing glare, but do not provide an adequate concentration of beam. The most practical solution, apparently, is to keep all the light below the eye-level whilst giving maximum intensity just below the boundary.

According to the author, the suggested ideal beam should consist of (*a*) a bright penetrating light, very shallow and relatively wide, projected along the road surface below eye-level; (*b*) a much wider beam, not so bright, illuminating hedges, road, etc., all below eye-level; and (*c*) a generally diffused beam of low tensity close to the car.

The lecturer contended that these conditions could not be fulfilled by any simple attachment to the ordinary parabolic headlamp, but only by some form of optical projection apparatus using at least one lens. Such a device, it was suggested, need not be more complex or expensive than the present-day headlamp, though a somewhat longer length might be necessary to get the desired concentration.

In the course of the discussion, Mr. D. Ritchie showed a form of headlight which was specially designed to give the desired sharp boundary, retaining the light below the eye-level, and other speakers referred to various practical problems involved in the consideration of motor headlights in relation to street traffic.

It was announced that the next meeting would take place on April 26, when there would be a discussion on ship lighting.

ELECTRICAL BUSINESS IN SPAIN.

"Although the reaction from the war period of prosperity is beginning to be felt here as elsewhere, it is instructive to note that the exports from Spain to the U.K. show 120 per cent. increase in 1920, as compared with 1913, and the returns of exports from the U.K. to Spain show 146 per cent. increase for the same period. With the acknowledged preference for British materials and manufactures, the future of British trade with Spain should be assured, provided that sufficient study is made of the requirements of the country." Thus says Capt. U. de B. Charles (Commercial Secretary to H.M. Embassy, Madrid) in the General Report on the Industries and Commerce of Spain, just published by H.M. Stationery Office at 1s. 6d. net.

A spirit of independence was created during the war, and the 1920-21 period is marked by an endeavour to establish that independence by increased taxation against the foreigner and a tendency towards the nationalisation of Spanish industries. The Catalan and Basque manufacturers have urged the introduction of increased tariff protection, and have received the support of the Government, and it is to be expected that these protective measures will be on the horizon for some time to come. But even with these protective measures, the Spanish market will not be closed to the foreigner owing to the fact that Spain is still unable to supply the increasing demands of the country.

With regard to imports, the largest class, after foodstuffs, is that which includes machinery, electrical material, ships, motor-cars, and musical instruments. In this class the increase in 1920 over 1919 is 120 per cent., and compared with the year before, 300 per cent. Especially interesting is the trade in electrical material, motor-cars and lorries, and agricultural machinery. Of all these goods, for which the demand may be expected to become increasingly active, the U.S.A. is at present the largest supplier. The import of dynamos and electric motors in 1919 was 3,100 tons, more than half from the U.S.A.; 800 tons came from Switzerland, the U.K. provided 340 tons, Sweden and France the remainder. France follows the U.S.A. as the second largest source of accumulators. In electric cables the U.K. is second. The U.S.A. is also first in carbons. Electric bulbs are obtained chiefly from Holland and the U.K.

THE ELECTRICAL INDUSTRY IN DENMARK.

The branch of Danish industry that would seem to be in the most satisfactory condition is that manufacturing electric motors and dynamos. Of these there has been no inconsiderable export both to Sweden and Norway, and also to other markets, while there is also a considerable demand in Denmark itself, where small electrical motors are much used in agricultural districts. In this connection it may be mentioned that great interest is being shown in the development of electricity in that country. At present the large electric power stations on the Islands are mainly driven by coal or oil engines. On Jutland, however, efforts are being made with some success to harness water power, while in other cases plants have been installed in which peat can be used as fuel. In some of these latter cases the farmers have made arrangements whereby electricity is delivered to their farms from the high-tension systems in return for peat delivered by the farmer to the power station. The general question of the further development of the use

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of electricity is attracting the interest both of the Government and of such institutions as the Chamber of Manufacturers. Schemes are under discussion for the generation of electricity by means of wind-mills, and also for a more complete utilisation of the water power available. Further it is suggested that electricity might be transmitted from one or other of the great water power stations of Norway or Sweden to some point on the coast of Jutland, whence it could be distributed over the peninsula and linked up with already existing or contemplated local power stations. The realisation of this scheme would, it is admitted, be exceedingly expensive in view of the length of submarine cable required, but its advocates maintain that it would be economically sound so long as the c.i.f. price of coal in Denmark exceeds 50 kroner per ton. (Gen. Report on the Economic Situation in Denmark at the end of 1920, by Mr. R. M. Turner, Commercial Secretary to H.M. Legation, Copenhagen.)

ELECTRICITY DISTRICTS.

Once again have we been notified of an extension of time for objections, etc., in the case of an Electricity District, this time the proposed S.W. Mid. District. Is anything tangible ever coming through the present obstruction and delay? Probably not. Why? Because there is a general belief (well-founded, we believe) that company management is to be preferred to an electricity committee composed of members of Town Councils with no special knowledge of the business and no incentive to commercial enterprise. There can be no objection to Joint Electricity Authorities if their functions are purely advisory, but let the whole supply business be taken over by companies under the control of the Electricity Commissioners. Adequate funds would be forthcoming in this case, and some of us would get, at a reasonable price, the supply of electricity we are now waiting for and look like waiting for for many years. Quite enough public money has been wasted in preliminaries.

NEW DESIGNS IN ELECTRIC TOOLS.

Some new electric polishing machines, specially designed to suit the jewellery and electro-plate trades, have just been placed on the market by the Consolidated Pneumatic Tool Co., Ltd. (Egyptian House, 170, Piccadilly, W.1).

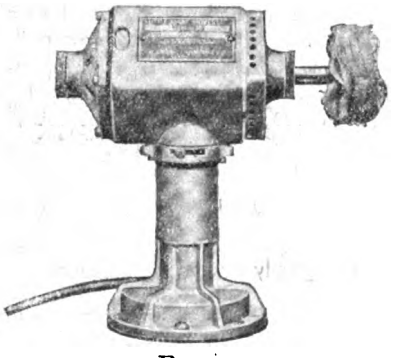


FIG. 1.

A small electric buffing machine is shown in Fig. 1. Mounted on a pedestal and fitted with a switch on top of the column, this useful machine takes a buff up to 2½ in., and is specially suited for polishing jewellery, scientific instruments, and fancy metal goods. It weighs only 7 lb., is built on sound engineering lines and is fitted with ball bearings. It will work on either direct or alternating current, its consumption being so small it can be operated from an ordinary lampholder.

The electric hand buffing machine shown in Fig. 2 is designed for use in motor-car works, garages or show-rooms, where light, easily transportable machines are required for buffing small metal parts. Ball bearings are fitted, and these machines will work on D.C. or A.C., and, like the foregoing, may be operated from a lampholder.

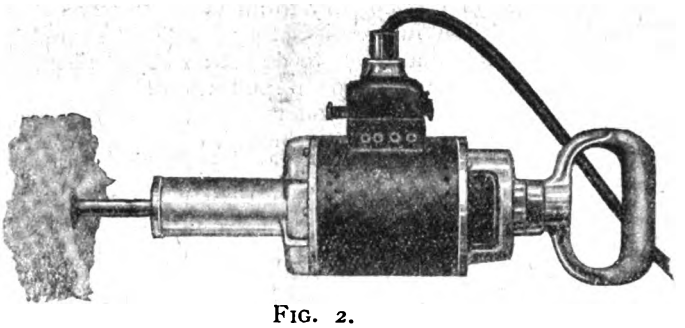


FIG. 2.

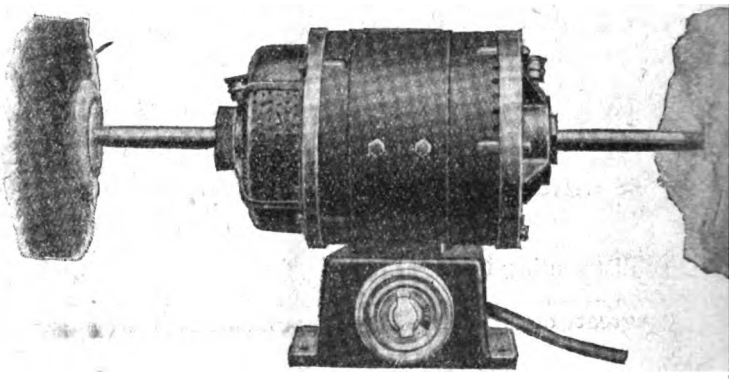


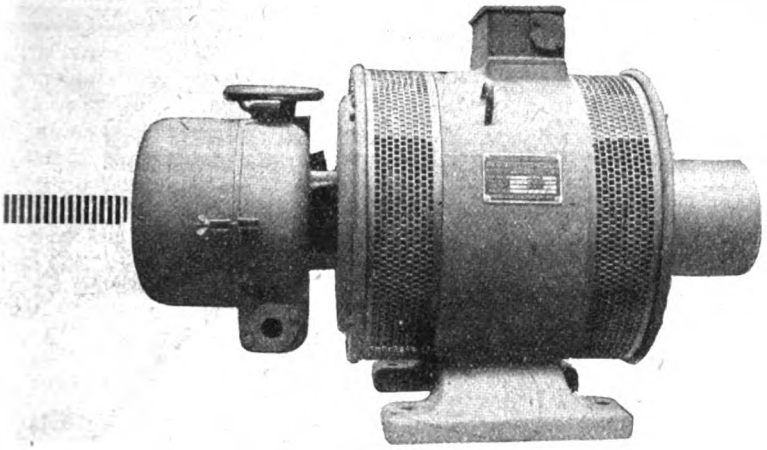
FIG. 3.

The larger and more powerful electric buffing machine illustrated in Fig. 3 is for gold and silversmiths, motor-car and cycle, cutlery, electro-plating and other industries where it is necessary to deal with highly polished articles of a larger size than can be dealt with by the smaller types. This machine has a 1 h.p. motor fitted with ball bearings and a substantial switch, and is mounted on a cast iron base. The motor has a fine and coarse buffing disc at either end, and will run on either D.C. or A.C.

These machines, by reason of their design and balance, are practically noiseless and vibrationless, and much more efficient than the usual belt-driven apparatus of similar type.

Belfast.—At the monthly meeting of the Corporation on the 1st inst., the Electy. Committee reported that the tender of the Concrete Piling Co., at £76,863, for the new Power Station at the Harbour had been accepted. It was not the lowest, but the others contained conditions which could not be entertained. This company also had the contracts for the foundations. Sir James Johnston in moving the acceptance of the tender said that the Committee had decided to install the second 6,000 k.w. set in the temporary station without additional boilers. This would increase the output by about 2,500 k.w. It was recommended to apply to the Electricity Commissioners for a supplemental loan of £14,000 in addition to the £24,000 applied for February 1 last. The purchase of two circulating water screens at £2,750 was approved. There was considerable discussion on the foregoing recommendations, but all the amendments were negatived.

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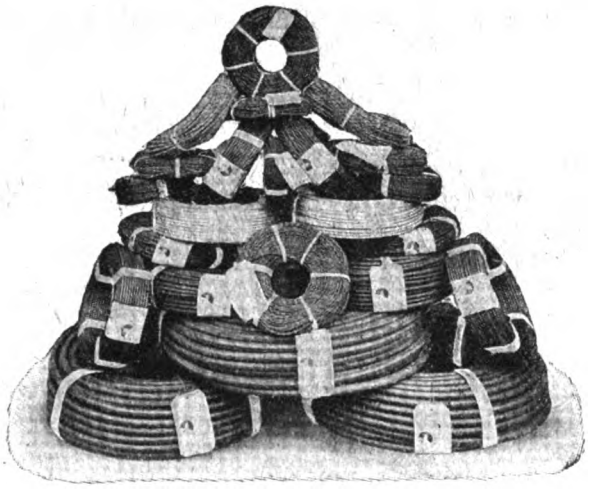
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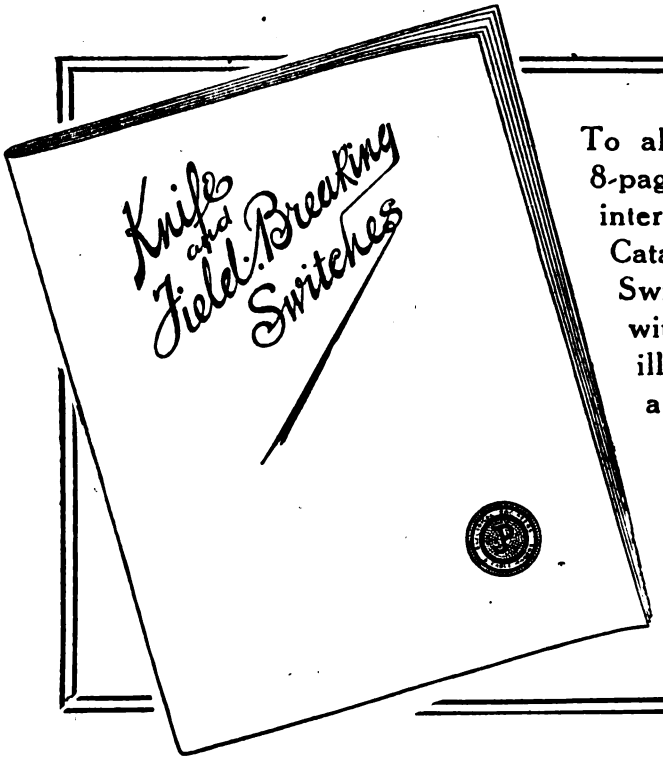
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TO OUR READERS.

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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter, in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Coal.

Whatever the issue of the crisis in the mining industry which exists at the time these notes are written, the present dispute, together with other quite recent examples in the same industry, that of coal-getting, serve to bring home to us how absolutely dependent we are upon coal for our national well-being. Coal as the natural mineral fuel of these islands is our chief source of energy; without it we should soon become a derelict community, for, not only does it constitute one of our principal export commodities, but it is also the fundamental basis of practically all manufacturing processes. Without coal, and in the absence of any appreciable or comparable water power, we should sink to the position of a third- or fourth-rate Power in the world's economics.

In the circumstances, and quite apart from the pros and cons of the miners' present claims, it is surely wrong in principle that a section of the community, numerically weak in relation to the remainder of the population, should possess the power by co-operative action of condemning the country to the huge losses and unemployment consequent upon a stoppage, however brief, of the important industry of coal-mining. This is not a diatribe against trade unionism; the miners have a perfect right to combine in their own interests just as much as any other body of workers; but, in view of the vital importance to the nation of its coal supplies, it would appear urgently necessary that some other method of dealing with this natural and national wealth than the present should be forthcoming.

I am no advocate of nationalisation, realising only too well the hopeless inefficiency of any scheme of State control of so important an industry. Nevertheless, the problem might be partially solved and national ruin averted by Government ownership of some of the coal-fields. It is such a terrible indictment of civilisation that in this twentieth century a body of industrial workers of all grades, upon whom we depend for our basic fuel, should be so adversely influenced as to jointly uphold a policy which makes for national bankruptcy, with the avowed object of achieving a set purpose in regard to wages. I have often stated in these comments that an industry which cannot support itself has no right to continue its existence. The coal-mining industry under existing conditions is not self-supporting, and therefore comes under this ruling.

On the other hand, coal is essential to our national livelihood, and we must therefore seek a remedy for the trouble. Coal-mining is a non-paying industry at the present time because of the cost of winning it. We have the most modern and up-to-date appliances; we are the premier coal-mining nation in this respect. Therefore, we cannot well reduce the cost of coal per ton by further improvements. The main item in its present cost is the labour involved in mining it, and, until the wages of coal miners assume a more normal level, we cannot hope to appreciably reduce the cost per ton. This is plain fact, obvious to everyone concerned.

Public Lighting Responsibility.

A case of considerable importance to local lighting authorities outside London has recently been decided in the Court of Appeal. It arose out of an action brought by a Glossop resident against the Glossop Corporation for damages arising out of the alleged negligence of that body in having extinguished a street gas lamp at a dangerous spot within their area. Owing to the absence of light at this point the complainant fell over a retaining wall into a country lane, and was seriously injured. At the Manchester Assizes, Mr. Justice Greer upheld the claim, against which decision the Glossop Corporation duly appealed.

In giving judgment, the Appeal Court stated that the Statutory authority of the Corporation for lighting the district was to be found in Section 161 of the Public Health Act, 1875. That section gave the Corporation authority to light their district, but it created no obligation upon them to light it. It gave them full discretion as to the times during which the lamps should be kept alight in any portion of their district which they elected to illuminate. There was a very great distinction to be drawn between the powers given to local authorities under this section and the power given under Section 130 of the Metropolis Management Act, 1855, where not only were authorities given power to light streets, but they were placed under a distinct statutory obligation to light them. The appeal was allowed, and judgment entered for the Corporation.

The case serves to bring out the anomalies at present existing in our laws relating to public street lighting. In one district the obligation is on the local authority to see that the streets are properly illuminated after dark, and the safety of the populace thereby assured. In another district, and under a more modern enactment, a similar local authority can please itself whether or no it lights the streets at all, and has discretionary powers as to the times of lighting. Since it is obviously to the advantage of everybody, whether in London or provincial towns, that streets in populous areas should be well lighted after dark, it would appear highly desirable that any powers for public lighting conferred either upon a corporation or a company should invariably be accompanied by some proviso ensuring the due performance of the service for which powers are conferred.

I have previously commented on the lack of uniformity in public lighting, and instanced the urgent need for standardisation and reform in this important field. With the law on the subject as it is at present, there is obviously room for legal reform also. It is anomalous to grant any body, corporate or otherwise,

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permission to render a much-needed public utility service, and at the same time leave that body free power to determine whether or no it carries out the scheme for which permission has been obtained. Public safety demands some more satisfactory guarantee.

American Lamps.

In view of the enormous production of electric lamps in the States, it is rather surprising that American bulbs are not more in evidence in this country than is the case at present. Incidentally, it also shows that British lamp manufacturers are quite capable of holding their own in this important industry. In the U.S.A. the production of electric lamps continues to rise, the figure of 230,000,000, excluding miniature bulbs, being attained for 1920. In addition, no fewer than 125,000,000 miniature lamps were manufactured during the same period. It is also interesting to note as indicative of the passing of the carbon filament that such lamps now only constitute about 7 per cent. of the total.

Steam Turbo Sets.

A valuable and instructive paper on some recent developments in large steam turbine practice was read on Thursday of last week by Mr. K. Baumann, before the I.E.E. Some points in it I hope to refer to later on, but it might be stated that from the discussion it appears that a unit of 20,000 kw. is about the largest size desirable or necessary to use in this country, and the speed 1,500 r.p.m. Luckily we do not have to run at 3,000 r.p.m. (though 15,000 kw. sets at 3,000 r.p.m. have their advocates) as has been forced on America, where, by the way, machines up to 70,000 kw. are in operation, as 50 is the highest commercial frequency here as against 60 over the water. Although there was a time when the impulse turbine appeared to be going to take the field for large units, the blading of the reaction turbine has now been so much improved that this type appears to be more than holding its own. Given careful design, good materials and sound workmanship there is no reason why the larger-sized turbo sets should give any trouble in operation, but it is certainly desirable that the normal speed should be below the critical speed of the set.

ELEKTRON.

ELECTRICITY SUPPLY IN BIRMINGHAM.

At the Birmingham and District Electric Club on Saturday, April 9, a paper was read by Mr. Frank Forrest, M.I.E.E., Chief Assistant Engineer to the Birmingham Electricity Dept., upon The Supply of Electrical Energy in Birmingham and District.

The subject was dealt with under three main divisions:—

(1) A history of the Birmingham Municipal Undertaking;

(2) A description of the plant installed in the Birmingham Supply Stations;

(3) A reference to the future of Electric Supply in the West Midland Industrial Area.

The paper was fully illustrated with lantern slides, and the latter portion dealt in a masterly way with the vast possibilities for electrical developments in the area, and gave some account of the steps which were actually being taken and which were proposed for dealing with the supply of energy.

SOME REMARKS ON LABOUR, TRADE AND PROSPERITY.

The Report of the Council of the B.E.A.M.A. was presented at the Annual Meeting on the 17th ult., and in proposing its adoption the Chairman, Mr. W. O. Smith, Elliott Bros. (London), Ltd., in the course of his speech made some remarks which might with profit be read by the masses:—

"I wonder if those members present read carefully the speeches of the chairmen of the leading English banks at the recent general meetings? I cite the banks because they have connections with all the manufacturing concerns in this country, and, therefore, have a knowledge of all branches of trade. The speeches were quite interesting reading, although there was a strong vein of pessimism in evidence in all of them. The chairmen did not all agree as to the cause of the present position. One appeared to attribute it to E.P.D., another to instability of exchange, another to restriction of output by workpeople, another to the large increase in wages, and yet another to extravagance and unfair treatment on the part of the Government. It seems to me, however, that no one of these causes alone can be the reason of the trouble, but rather the cumulative effect of these and other causes, such, for instance, as the unsettled condition of the coal mining industry, on which the prosperity of this country depends to so large an extent, and further, to the fact that after the strain of the War, and the anxieties of that period, there followed a period of exhaustion and inaction, from which we have not, even up to the present, quite recovered.

"In my view, before the country, generally, and our industry in particular, can be brought up to a state of efficiency again, harmonious working between employer and employed is an absolute essential. (Cheers.) The employer must pay a fair and reasonable wage, and the employed must be prepared to give a full day's work for a full day's pay, and must also realise that the excessive wages which the employed extracted, directly or indirectly, from the Government in time of emergency, cannot be continued now that the industries have again reverted to private enterprise, and severe competition has to be met. It is up to the workpeople to decide whether they wish to be employed or unemployed; if they insist on extracting the last penny from the employer, only unemployment can result. There is no doubt that unemployment is still on the increase at the present time.

"If we can believe all we read in the newspapers, the workpeople in some industries are beginning to see the effect of excessive wages, and are themselves approaching the employers with offers of reduction, rather than find themselves out of work. That, if true, is an encouraging sign.

"And now, what can we, as an Association, do to meet the present situation? It seems to me that never before has there been such a need in the electrical and allied industry for co-operation. (Hear, hear.) Although we may compete in friendly rivalry in our own country, let us present a solid front to the enemy, even if we have to make sacrifices for the moment; let us not think and act as individuals only, but rather as an Association whose common aim is that of the good of the industry and its members in bringing back trade to this country."

ASBESTOS WOVEN RESISTANCE NETS AND GRIDS.

The Photector Co., Ltd. (Central Hall, Southall), supply resistance nets and grids suitable for light or heavy current work and either rigid or flexible for working at temperatures up to 600° C. (1,660° F.) The units can be any size from ¾ in. to 19 in. wide and the length up to 60 ft. They are fundamentally composed of warps, of specially spun asbestos, spaced at distances, with wefts that consist of wire, flexible cable or strips made of Nickel Silver, Constantan, Chromnickel, etc. Any necessary tappings

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required for variable resistances are woven firmly in place so that the completed unit is strong and durable.

They can be utilised for such purposes as heating pads, convector pattern fires, cookers, furnaces, motor starters and controllers, etc., and possess an advantage in offering a high energy absorption with minimum weight.

TELEGRAPHY.

Being Solutions to the Questions set in the Final Examination in Telegraphy held by the City and Guilds of London Institute in April, 1920.

(*Continued from page 202.*)

Q. 6.—When signals are being transmitted to line on a fast-speed simplex Wheatstone circuit the movements of the galvanometer needle are only just perceptible, whilst the lamp resistance is observed to glow with a dull red heat. Give a full explanation of the cause of these effects.

A.—The phenomena referred to in the question are usually observed only on circuits possessing considerable capacity and worked at a high rate of signalling. At very high speeds Wheatstone signalling consists in applying what is approximately an alternating e.m.f. to a circuit; the application of (say) a marking e.m.f. results in the passage of an exceedingly high sending current in order to satisfy the capacity of the line, and this initial current is far in excess of the steady current which would flow normally. Before the current has time to reach the latter state, however, the applied e.m.f. is reversed in order to terminate the mark; the consequent discharge of the line and its recharging in the opposite direction causes an extremely high reverse current to flow at the sending end. Similarly the same is the case when the e.m.f. is reversed again for sending the next mark. The marks and spaces in high speed working follow one another so rapidly that the current through the line and the galvanometer at the sending end approximates to a succession of extremely heavy condenser impulses continually changing in direction.

Now the needle of a galvanometer is comparatively heavy and its time of swing is slow with respect to the rapidity of the reversals of the signalling currents, so that it has not time to take up a final position for one direction of current before the reverse current passes through the coils and tends to set the needle moving in the opposite direction. Usually on circuits of very high capacity the needle takes up a permanent deflection corresponding to the direction of the first e.m.f. applied to the line.

The lamp resistances being in the battery leads, it therefore follows that the current through them consists of pulsating condenser charges, and the latter are of sufficient magnitude to cause the lamps to glow. The interval of disconnection of a lamp resistance, i.e., when the opposite pole of the battery to which it is connected is being applied to the line, is of such short duration in high speed working that the lamp resistance has not time to get cold and it consequently glows continually.

Q. 7.—Describe the construction of any type of secondary cell, and state how you would express the output from it. What percentage of the energy given to such a cell would you expect to be delivered?

A.—In the Hart accumulator the plates are of the semi-Planté or partially-pasted type. The positive plate is in the form of a grid having horizontal ribs running from side to side, with vertical ribs an inch apart connecting the horizontal ribs. In the centre of the grid is a solid diaphragm, the whole resulting in a very strong plate capable of withstanding any buckling tendency. The grid is partially pasted with a special active material which is highly porous yet hard and durable. This active material ensures the initial capacity being obtained, and as the working of the cell proceeds the grid itself gradually becomes formed until it reaches the requisite capacity, which is maintained during the whole life of the cell. To prevent any tendency of the active material from falling, the complete plate is subjected to a rolling pressure, which turns the edges of the horizontal ribs slightly upwards, thus closely uniting the grid and paste.

The negative plate is of the lattice-work cage type, having the vertical ribs on one side staggered with respect to the ribs on the other side. The active material is of special character; it consists of strips of pellets running horizontally from side to side of the plate, and locked securely in position by the staggered ribs.

The plates are suspended by two projecting side lugs from the top edges of glass slabs which rest in grooves in a wooden bottom or tray. The plates are kept from touching one another by thin sheets of nitrated cellulose placed between them. These separators are not attacked by the electrolyte or by gases evolved during charging; they cover the plates completely and effectually prevent internal short-circuiting. The plates are connected together by non-corrosive terminals of a special lead alloy, while the cells are connected together by coned bolts fitting tightly into the terminal lugs. This arrangement reduces the resistance to a minimum and is much more satisfactory than the old brass stud and nut connection. A clear space is left beneath the plates for any deposit which may accumulate after long intervals.

The electrolyte is dilute sulphuric acid. When fully charged the specific gravity should not be less than 1.200, and the discharge should cease when the specific gravity falls to 1.170.

The output of a secondary cell may be expressed either in ampere-hours or in watt-hours. The former is the more usual method and is represented by the product

$$c \times t$$

where c = the average discharge current in amperes and t = the time of discharge in hours

The watt-hour output is a measure of the energy delivered by the cell and is represented by the product

$$c \times t \times E$$

Where c and t are as above and E is the average voltage of the cell during discharge.

The energy or watt-hour efficiency, which is equal to $\frac{\text{watt-hour output}}{\text{watt-hour input}} \times 100$ per cent., depends upon the discharge rate at which the cell is worked, and under favourable conditions may be as high as 75 per cent.

Q. 8.—What are the fundamental arbitrary units selected from which the absolute system of electrical units is derived? Show how the practical units of current, electromotive force, resistance and capacity are related to the equivalent C.G.S. units.

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A.—Electrical units are based on a system of measurement known as the centimetre—gram—second or C.G.S. units. The C.G.S. system has the following fundamental units :—The *centimetre* is the unit of length and equals .3937 inch. The *gram* is the unit of mass, and is defined as the mass of 1 cubic centimetre of pure water at a temperature of 4°C. 1 gram = .0353 oz.

The *second* is the unit of time.

Derived units.—The *dyne* is the unit of force, and is defined as that force which acting on a mass of 1 gram for 1 second gives to it a velocity of 1 centimetre per second.

The *erg* is the unit of work, and is defined as the work done by a force of 1 dyne acting on a body through a distance of 1 centimetre.

There are two systems of absolute units employed in electrical measurements, derived from the fundamental C.G.S. units, viz., the *electrostatic units* and the *electromagnetic units*. The former are based upon the attraction or repulsion between electric charges, and the latter are derived from the attraction or repulsion between magnetic poles, and are employed for the measurement of current, electromotive force, etc. The principal electromagnetic units are defined as follows :—

The C.G.S. unit of current is that current which when flowing along a wire 1 centimetre in length, bent into the form of a circular arc of 1 centimetre radius, exerts a force of 1 dyne on a unit magnetic pole placed at the centre of the circle, of which the arc is a part.

The C.G.S. unit of electromotive force is said to exist between two points on a conductor when 1 erg of work is done in moving *unit quantity* of electricity from one point to the other along the conductor, the unit quantity being defined as the quantity of electricity conveyed by unit current in 1 second.

One C.G.S unit of resistance is possessed by a conductor when a unit difference of potential between its ends causes a current of unit strength to flow through it.

A conductor is said to have 1 *C.G.S. unit of capacity* when a charge of 1 unit of quantity of electricity raises its potential from zero to unity.

The following table shows how the practical units are related to their equivalent C.G.S. units as defined above :—

The ampere, the practical unit of current, is 10^{-1} absolute units.
The volt, the practical unit of E.M.F. is 10^{8} absolute units
The ohm, the practical unit of resistance, is 10^{-9} absolute units.
The farad, the practical unit of capacity, is 10^{-9} absolute units.

(To be continued.)

Electrical Developments in N.Z.—The *New Zealand Gazette* for January 20 (No. 6), contains Orders in Council (1) giving consent to the raising of a loan by the Auckland City Council of £500,000, for the purpose of extensions to the city electrical station ; (2) authorising the erection of electric lines at Waiwera. The *Gazette* for January 13 (No.3) publishes an Order in Council authorising the Inangahua County Council to erect electric lines at Waiuku, whilst the issue for February 3 (No. 9), notifies that similar authorisation has been given for electric lines at Thames, Hokitika, Westland County, and Gore, and for a transmission line in Mataura and Southland County. The same issue (No. 9) notifies that local approval has been given to the raising of a loan of £60,000 to be devoted principally to the erection of electric power transmission lines at Springs-Ellesmere.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 115.

Can any reader give me some information concerning the testing of steam turbines and generators?—"VACUUM."

QUESTION NO. 116.

I would appreciate full constructional details of a resistance which is to reduce 100 volts to 80 volts when a current of 5 amperes is passing for an indefinite period. How shall I wind the wire? Will mica or enamelled insulated steel tubes be satisfactory?; and what size and kind of wire is most suitable if the temperature is not to exceed 300 deg. F.? The resistance is to be enclosed in a flame-proof box, and the use of oil, for cooling, is prohibited.—"B."

(Replies to Questions Nos. 115 and 116 must be received not later than April 30, 1921.)

Answers to Questions.

QUESTION NO. 112.

No replies of a satisfactory nature were received to this question. It has, therefore, been decided to make no award.—THE EDITOR.

QUESTION NO. 113.

I have received advice to fit magnetic clutches in my machine shop instead of the fast and loose pulleys so necessary for machine operation. Can any reader tell me how these are operated, and what type of clutches I shall require? My lighting voltage is 230 volts.—"PLANER."

REPLIES TO QUESTION NO. 113.

The first prize (10s.) has been awarded to "Astatic" for the following reply :—

I am afraid the advice that "Planer" has received concerning the fitting of magnetic clutches for machine operation, in preference to fast and loose pulleys, is not as sound as it might be. Speaking as an electrical engineer who has had considerable experience in magnetic clutches, I must express the opinion that at the present moment I would not dream of replacing the fast and loose pulleys in my machine shop for magnetic clutches. However, "Planer" desires details, so I will give him the benefit of my experience.

In the first place the voltage, 230 volts, which is probably the pressure between the outer and neutral of a three-wire system, is not suitable for magnetic clutches. With such a system it is possible to obtain a pressure of 460 volts across the clutch, although this may occur only for a moment. Such an additional pressure would probably break down the insulation of the coils and so place the clutch out of action. I have referred to the above because I have known such conditions to develop.

This would mean that if the clutch is to operate at a *safe* pressure, a motor-generator will be necessary to transform the voltage down to a suitable pressure. The cost

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of a motor-generator must be added to the initial cost of the clutch installation, from which it will be seen that the total cost will be increased probably as much as 25 per cent.

The most suitable voltage for magnetic clutches from my experience is 20 volts. This, of course, to obtain a maximum magneto-motive-force means a clutch of considerable size. In a clutch required to drive a large planing table there would be probably six or eight coils, thus providing for three or four complete magnetic circuits. The clutch plate, which is usually keyed to the driving shaft, is made of thin mild steel and is perforated with holes which are usually a little smaller than the diameter of each pole core.

The coils for such a low voltage are wound with copper strip and are suitably insulated. They are held in position by pegs which prevent them moving under the action of centrifugal force. The joint between each coil is satisfactory if a clearing hole is drilled in the end of each strip and a small bolt, fastened with a nut, passed through them. If there is sufficient space it is not necessary to tape the joints, the strip being sufficiently strong to prevent a great deal of movement. The coils are connected in series, one end being earthed and the other end is brought out through an insulating bush to a slip ring.

This slip ring is usually made of a good quality of gunmetal, with a groove cut in its periphery to receive a spring contact by means of which current is transmitted to the coil from the source of supply. Considerable care has to be exercised when selecting the most suitable type of spring contact. I have seen them fitted with carbon contacts of a circular pattern, obviously to reduce wear due to sparking, although it would appear to be sound design if the possibility of sparking was entirely eliminated. The tension of this spring appears to be the most important factor. It is necessary that an even tension must be maintained. It is to be regretted that there is considerable difficulty in this respect.

The most convenient method of energising these clutches is by means of tumbler switches of suitable carrying capacity. These may be placed "on" or "off" at the will of the operator. The position of the switch is in a convenient position to the operator, usually on the machine. Sometimes, however, where the energising of the clutches is quite automatic, such as in the operation of planers, a special two-way switch has to be designed.

Regarding advantages, it is very doubtful if there are any. It is not much trouble for an operator to pull a lever over instead of operating a switch. In fact, some operators will tell you that they can centre a job in a lathe much better with a fast and loose pulley than with a clutch. Before "Planer" *electrifies* his fast and loose pulleys he should obtain expert advice. Although I am not an expert, it is safe to predict that the advice will be on the lines mentioned above.—"ASTATIC."

No second award is made.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

ARITHMETIC OF TELEGRAPHY AND TELEPHONY. By Herbert and De Wardt. (187 pages, 38 diagrams. Pitman, 5s. net.)—Hardly a year passes without the City and Guilds' examiners in Telegraphy and Telephony complaining in their annual reports of the unsatisfactory attempts made by students to answer questions involving an elementary knowledge of mathematics. The examiners declare that the papers as a whole show an almost complete absence of knowledge of the arithmetic of the subject, and that it is almost impossible to frame a question of a mathematical character that is simple enough to be within the ability of more than a small percentage [illegible] before us should go far [illegible] introductory chapter, which [illegible] simple arithmetical and algebraical [illegible] pass set themselves by the authors, [illegible] in the chapter are treated very [illegible] space is devoted to complex fractions, [illegible] to simple equations. The authors say [illegible] need of students to guard against [illegible] tions beyond a point warranted by the [illegible] but they do not describe contracted [illegible] of so much assistance in making accurate [illegible] Chapter I. deals adequately with Ohm's law, [illegible] extensions, and other chapters follow dealing [illegible] ments of cells; resistances in series and [illegible] resistance formulæ; measurement of current, [illegible] force and resistance; localisation of faults, etc. [illegible] best chapter in the book is that dealing with the [illegible] of sags and stresses in overhead lines; it contains a full account of the parallelogram and triangle of forces, and is supplemented by many practical examples. The concluding chapter deals briefly with curve-plotting; it contains among other matter several examples of the variation of current under different conditions, and it might fittingly have included an example or two illustrating the characteristic curves of magnetic specimens. Although the book is intended to cover the syllabus of the Grade I. examinations, we see no good reason for omitting all mention of Kirchhoff's laws, without some account of which no book of this kind can be regarded as complete.

There are many examples scattered about the book with which the student may test his powers of working problems, and there is a full index of contents. So far as we are aware this is the only publication in the English language dealing specifically with the arithmetic of Telegraphy and Telephony, and notwithstanding the minor defects alluded to above, the book should be of the greatest use to telegraph and telephone workers, and it is certain to secure a large circulation.

ELEMENTS OF VECTOR ALGEBRA. By L. Silberstein. 42 pp. 12 figs. (Longmans. 5s. net.) The author is a well-known writer upon vectors and their applications, and in this book he renders great assistance to students by presenting a treatment of the elements of vector algebra, forming an easy introduction to this subject. The book is framed primarily for the needs of those engaged in geometrical optics, but the applications of vector algebra are ever extending, and we believe that a study of this work would help those who are embarking on a study of vectors in relation to the more advanced problems of alternating current engineering.

WHITAKER'S ALMANAC, 1921. (Whitaker. Paper, 3s. net; cloth, 7s. 6d. net).—Various improvements and additions have been made to the new edition of this always welcome work of reference, including extensions to the lists of societies and institutions, additions to the legal notes and certain short historical sketches, while, from a geographical point of view, new articles dealing with places like Mesopotamia, Armenia, Austria, Danzig, etc., have been included. There is an excellent summary of the developments in regard to science and invention during 1920, and the British Empire industries section supplies much miscellaneous information concerning British manufactures. Altogether the book is of the greatest possible value in every office from a commercial point of view.

The Photographic Fair.—This fair, which opens at 10 o'clock on Friday, April 15, at the Horticultural Hall, Vincent Square, Westminster, will be full of interest to all photographers. Novelties in apparatus and processes, demonstrations and clever portraiture being amongst the attractions.

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Trade Notes.

An **Osram-G.E.C.** lamp catalogue of 40-pp. and attractive cover, based on the glories of an eastern sunrise, is now available. There is a reference to the Osram-G.E.C. Lamp Works, a description of the design and construction of Osram gasfilled lamps, and some notes on illuminating engineering. All kinds and sizes of vacuum and gasfilled lamps, as well as flash-light and Robertson lamps, are listed complete, with particulars of construction and dimensions. The ruling reduced prices are given.

Meldrums, Ltd. (Timperley, near Manchester), inform us that they have recently fitted the "Meldrum" forced draught furnace for economising in fuel consumption, to a large water-tube boiler at the Barugh Power Station of the Yorks E. P. Co. They send also the second numer of "Meldrum's Magazine," which keeps up the reputation of the first for entertaining matter and illustrations, combined with valuable suggestions as to the economy and health promotion obtained by the correct disposal of refuse in large and small quantities.—Meldrums are now represented in Birmingham district and the Black Country by **Mr. H. Astbury** (Empire House, Birmingham).

Messrs. H. W. Smith and Co. (1920) Ltd., Wire and Cable Manufacturers, of Lydbrook, Glos., and Central House, Kingsway, London, W.C.2., have appointed Mr. C. H. Spafford, 20, Falmouth Road, Bishopston, Bristol, as their representative for the West of England. His telephone No. is "Bristol 5373." For a long time Mr. Spafford was with Messrs. Simplex Conduits, Ltd.

Particulars of a 3 h.p. stationary paraffin engine, which is being placed on the market by the **Ailsa Craig Motor Co., Ltd.** (Strand-on-the-Green, Chiswick, W.4), are contained in a leaflet just issued. A second leaflet deals with electric light and power outfits for from 36 to 96 lights. The Company states that it is desirous of extending its relations with dynamo manufacturers and is in a position to supply the engines by contract at a very reasonable price.

The 1921 reprint of the "Witton" A.C. Generator Catalogue Section has now been received from the printers, and the **General Electric Co., Ltd.,** intimate that supplies are now available for their clients.

In Heat Treatment Bulletin No. 27, issued by **Automatic and Electric Furnaces, Ltd.,** 261-3, Gray's Inn Road, W.C.1., deleterious effects of overheating high carbon steel are dealt with, and the excellently uniform results obtained by the Company's process referred to. Employing a 12-inch Wild-Barfield radiation furnace fitted with magnetic detector, masses of 40 pounds are now being hardened as a regular routine. Perfect hardening is being obtained, and there is no reason for supposing that larger masses than this cannot be successfully dealt with. In general the larger the mass the greater the difficulty of arriving at its temperature, and the more necessary becomes the employment of some device or other, such as the magnetic detector, which tells one when the last grain of steel has completed its transformation. To demonstrate the effectiveness of the process the Company is prepared to harden samples of manufacturer's own tools, etc., free of charge, for a comparative test against similar articles hardened by the maker. It is instructive also to note that Wild-Barfield furnaces have been supplied to both America and Germany.

In the monthly magazine of **Higgs Bros.** (Sand Pits, Birmingham), there is the usual list of Dynamos and Motors in stock, together with practical hints on the subject of alignments, and the usual assortment of humorous jokes. This little catalogue is always well worth asking for.

Mr. J. B. Rudkin (212a, Shaftesbury Avenue, W.C 2), has been appointed representative in Great Britain for the **Sprecher and Schuh Coy.** (Aarau, Switzerland). This firm was founded in 1898, and specialises in the manufacture of H. T. and L. T. Switch gear.

Leaflets from the **Metropolitan-Vickers Electrical Co., Ltd.** (20, Brazennose Street, Manchester) describe automatic contactor type star-delta starters for 3-ph. non-reversing squirrel cage motors up to 650 volts.——Other leaflets deal with H. T. Contactors (type F) for controlling up to 300 amps., 3,300 volts, 3-ph. In conjunction with L. T. contactor gear for the rotor circuit, complete control of a motor is obtained. The reversing type is suited to colliery winders, rolling mills, etc., and the non-reversing type to continuous rolling mills, automatically controlled compresser equipments, etc.

Various Items.

Catalogues.—Readers who have to make drawings and tracings will be interested in the L7 Catalogue issued by Messrs. Stanley, of 286, High Holborn, W.C.1. They hold a reputation for splendid instruments, and the catalogue is well worth writing for.

Wireless.—Marconi's Wireless Telegraph Co. have restarted their deferred (L.C.O.) service to Canada, Newfoundland and the West Indies, which has been suspended since 1917. The cost of transmission by this route is less than that for a corresponding service by the Cable Companies.

Accrington.—An effort to refer back a recommendation in opposition to the restoration of penny tram-fares, has been defeated. Alderman Higham, chairman of Committee, said such a policy, however much they shortened their stages, would bring tramway undertakings on the rates. Nothing had been put away towards the renewal of the track during the past six years.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 15th inst., at Caxton Hall, at 8 p.m. Paper :—"The Metering of Steam," by C. R. Sams, Assoc. I.M.M. (Member). Slides. Also on Friday, 22nd, at Caxton Hall, at 8 p.m., Lecturette "Construction and working of Marine Water-tight Doors," by H. P. H. Anderson (Member). Slides. And on Friday, 29th, at Caxton Hall, at 8 p.m., Discursive Lecturette, "Rambling remarks on Expert Evidence," by W. A. Tookey, M.I.Mech. E. (Member).

Exhibition.—An International Exhibition of Shipping and Shipbuilding, together with National Exhibition of Marine Industries, will be held in Barcelona (Spain) in the spring of 1922. It will be under the Honorary Presidency of H.M. the King Alfonso XIII, and the Executive Committee has much pleasure in inviting shipowners, shipbuilders and engineering concerns from all over the world to attend the Exhibition, being confident, in so doing, to have interpreted the wish of the Spanish nation.

The Institute of Physics.—The meeting to inaugurate the Institute of Physics will take place on Wednesday, April 27th, at 6 p.m., in the Hall of the Inst. of Civil Engineers, Great George Street, Westminster. Sir Richard Glazebrook, K.C.B., President, will preside, and Sir J. J. Thomson, O.M., will deliver an address. Mr. A. J. Balfour is expected to be present and extend a welcome to the Institute. Non-members of the Institute and members of the Societies associat with it may obtain tickets of admission on application to the Se retary, 10, Essex Street, Strand, W.C. 2.

Benevolence.—A Smoking Concert which w s organised by the Local Advisory Committee for Manchester and District Electrical Trades Benevolent Institution, wa3 held at the Albion Hotel, Manchester, on Friday 1st inst., and over 200 were present. An excellent programme had been arranged by Mr. W. J. Smith, the energetic Secretary of the Committee, who also accompanied the songs. Mr. J. A. Robertson, the Engineer of the Salford Corporation, who is Chairman of the Committee, presided, and in the course of the evening he pointed out that the main object of the smoking concert was to induce some of the very large number of those in Manchester who are qualified to become Members to join the Institution. He expressed the hope, in view of the fact that there were more people on the staffs of the electrical firms in Manchester than in any other town, that the number of Members joining the Institution from that district would be greater than all those at present included in the list of Members. He afterwards called upon Mr. F. B. O. Hawes, Honorary Secretary of the Institution, who gave a short address on the objects and operations of the Institution, and drew attention to the fact that it was a duty as well as a privilege of every qualified person to be come a Member. Those present were enthusiastic in their desire to support the Institution and a considerable number of new Members joined.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
PRACTICAL TRADE JOURNAL
APRIL 22, 1921.

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SOME RECENT DEVELOPMENTS IN LARGE STEAM TURBINE PRACTICE.

General.

In the Paper read by Mr. K. Baumann before the Inst.E.E. on the 7th inst., the following were first dealt with:—(a) General trend of development, (b) development of the re-action turbine, (c) development of the impulse turbine, (d) comparison of commercial development, (e) development of turbines for special purposes.

In 1912 the author read a paper before the Institute describing the development of steam turbines to that date. The present paper continues the subject to the present time in a most comprehensive manner—the paper running to 60 pp. It is impossible to do justice to such an effort in a small space, but the following general notes may be of interest to our readers:—

The general trend of development towards the maximum possible output at the highest possible speed is justified for several reasons, the most important of which relate to reliability, thermal economy, and first cost. All of these factors are fully dealt with in this paper. This development towards large capacities is conditional on a corresponding development of the driven machine with which the turbine is directly connected, or, alternatively, of the gear used for transmitting the power to the driven machine.

The only machine which comes under the first category is the turbo-alternator. From a purely electrical point of view, the development of the high-speed alternator is not justified. The high-speed alternator is less efficient than the low-speed alternator, and its first cost is practically the same. Nevertheless, the advantages of the high-speed turbine fully justify the special endeavours of the electrical designers to overcome the obstacles with which they may be faced in keeping pace with turbine development.

During the past few years, the direct-current generator driven directly from the turbine has disappeared from the market. Its place has been taken by the moderately low-speed generator driven by mechanical reduction gear, up to units of 4,000 kw., and for large units by turbo-alternators in conjunction with rotary converters. The development of the reduction gear is also responsible for the disappearance of the direct-driven 25-cycle alternator running at 1,500 r.p.m. up to capacities of 4,000 kw.

The mechanical reduction gear has completely revolutionised the turbine practice for small outputs, and the time is not far distant when even the 1,000 kw. 3,000 r.p.m. turbo-alternator will be replaced by a turbine running at a high speed and driving the alternator through gears.

As in the case of the alternator, the development of the reduction gears towards a maximum possible output at a given speed is justified only from the turbine point of view. For a given speed in r.p.m. of the low-speed shaft, the cost of the gear increases with increasing pinion speed, but the more expensve gear is fully justified by the higher efficiency of the high-speed turbine and its lower cost. Whilst the gear is lagging behind the turbine in the race for maximum power, the fact must not be lost sight of that the gear is in the early stage of its development.

The most economical arrangement of the geared turbine for large capacities is the "two-pinion" arrangement, one pinion being driven by the high-pressure turbine, and the other by the low-pressure turbine. In such a case the output which can be transmitted through the pinions very nearly approaches the maximum output which can be obtained from the turbine when designed for a 29 in. vacuum.

With regard to low pressure and mixed pressure turbines, it is not surprising that the demand has considerably decreased. Low-pressure turbines used in conjunction with existing engines have practically disappeared, the tendency being to replace engines by high-pressure turbines, which are more economical than combined engines and low-pressure turbines. The demand for mixed-pressure turbines is still considerable, but there is a distinct falling off in inquiries in view of recent developments in the use of electricity for winders and rolling mills. Modern design practice for the mixed-pressure turbine is practically the same as in 1912, the only development being towards slightly larger sizes at 3,000 r.p.m., so that all capacities commercially required can be obtained with turbines running at 3,000 r.p.m.

The author then proceeds to deal analytically and critically with (1) important factors affecting the development of large turbines, (2) the economical rating of a given turbine frame, (3) the maximum output at a given speed, (4) governing. The latter, as is known, can be classified as throttle, or nozzle cut-out.

The characteristic feature of throttle governing is that at all loads below the economical load the steam is throttled to the pressure required to carry any particular load, and that loads above the economical are obtained by by-passing steam to an intermediate stage. In some cases two by-pass valves are used, each of which is connected to one or two intermediate stages. Each main throttle valve is usually designed to pass the full steam quantity required at the loads which it is designed to carry.

The principal disadvantage of throttle compared with nozzle cut-out governing is due, not so much to the fact that at light loads the former is less efficient than the latter, but to the necessity in the case of throttle governing of by-passing high-pressure steam to an intermediate stage in order to obtain loads greater than the economical load. It is clear that intermediate stages to which high-pressure steam is occasionally admitted must be designed to stand the high pressures and temperatures as if they were high-pressure stages.

The fact that such intermediate stages may be only occasionally subjected to high-pressure conditions does not in any way mitigate the objections to by-passing. The conditions under which these intermediate stages have to operate are in reality much more severe than those to which the initial high-pressure stages are subjected, since the magnitude of the temperature changes is greater in the intermediate stages than that of the temperature changes which occur in the initial stages with either throttle or nozzle cut-out governing. Such changes cause distortion and stresses in both the casing and the rotor.

Furthermore, all parts which may come in contact with steam at high temperatures must be made of cast steel. Cast iron will not withstand high temperatures. It is particularly unsuitable for parts which are subjected to variations in temperature, as it is the repeated heating and cooling which accelerates the growth of cast iron.

After concluding this subject the author proceeds to discuss recent steam consumption guarantees and concludes

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with operation experiences with large turbines, pointing out the difficulties met with owing to the increased peripheral speeds of the last wheels in single-flow machines, resulting in increased stresses. Another great source of trouble has been due to vibrations set up in various parts of the machines. The treatment falls under the following headings: distortion of turbine rotor and stator, deflection of diaphragms, cracking and breaking of turbine discs, breaking of moving blades, corrosion and erosion of blades, lubrication and bearings, governing, and steam leakage.

OPERATION.

As the success of large turbines depends to such a great extent on their proper treatment during operation, it may not be out of place to enumerate here the principal points upon which great attention should be bestowed:

(*a*) *Starting up.*—The principal object in starting up must be to obtain temperature conditions as close as possible to those existing when the turbine is running under load, i.e., the high-pressure end must be heated up whilst the exhaust end should be kept as cool as possible during the starting-up operation. The warming-up of the exhaust end should not be started until a considerable vacuum has been obtained—say 20 in. (Hg) Warming-up will be carried out to some extent by steam-sealing the glands, which should be designed in such a way that the quantity of steam necessary for sealing purposes should not be large, even when the glands are designed for water-sealing. When a vacuum of 25 in. has been reached, the turbine should be started by passing a puff of steam through the governor valve. The turbine should be kept running at about 10 per cent. of the normal speed for about 15 min., after which the speed may be increased to full speed at the rate of not more than 10 per cent. of the full load speed in one minute. When the turbine is brought to full speed, the low-pressure end will be hotter than when the turbine is running under load, and, in order to effect a gradual stabilisation in temperature, the load on the turbine should be increased slowly at the rate of not more than 10 per cent. of full load in one minute.

The above particulars apply to large 1,500-r.p.m. turbines. For 3,000-r.p.m. machines the time allowed for warming up can be considerably reduced. It may be of interest to repeat here the result of inquiries made by the Prime Movers' Committee of the National Electric Light Association as reported at the 43rd Convention at Pasadena, California, May 18-22, 1920 (Report of Committee on Prime Movers, page 5 of advance copy, published by National Electric Light Association).

(*To be continued.*)

MULTIPLEX TELEPHONY AND TELEGRAPHY WITH HIGH-FREQUENCY CURRENTS.

The following abstract is of an article by K. W. Wagner in *Elektrotechnik und Maschinenbau.*

It is possible to send several telegraph messages or to carry on several telephone conversations simultaneously over one pair of wires, due to the fact that high-frequency currents (f=100,000 and over) are inaudible to the human ear, and that receivers can be tuned to pick up messages only within given limits of frequency. Squier in America, and Rühmer in Berlin, carried out independent researches in 1909 and 1911 on this subject, but its practical application was only rendered possible by the development of the electrode tube transmitter and amplifier, the well-known principles of which are briefly described.

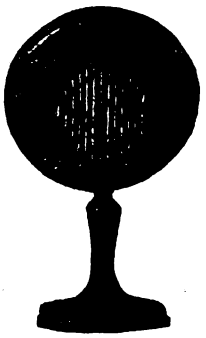
The writer carried out experiments for the German Government in 1919 on the Berlin-Hanover line (300 km.), whereby three simultaneous conversations were rendered possible over each existing pair of wires, without mutual interference or disturbance of the ordinary method of connection. Illustrations of the sender, receiver and amplifier used are given. Similar triplex working was afterwards installed on the Berlin-Frankfort line (600 km.), and the Berlin-Stralsund section of the new Berlin-Stockholm line has been fitted for duplicate working, thus leaving a line free for traffic between Berlin and the Baltic coast resorts. Experiments are now in progress on the Berlin-Breslau line (350 km.). It has been decided to install high-frequency plant on a large scale on the existing telephone network. Fifty sets are to be immediately installed between the main centres. A high-frequency trunk exchange is illustrated.

High-frequency multiplex telegraphy is being simultaneously developed. The Siemens rapid machine telegraph is used, this being capable of 800-900 words per minute. On the Berlin-Frankfort line six separate messages were successfully dealt with simultaneously, thus increasing the capacity of the line sevenfold.

The development of the high-frequency system is of great economic importance, as it permits a much needed extension of the present traffic capacity of the lines at a fraction of the cost of providing new lines, in the case of distances over a certain limit.—(*Technical Review.*)

A BOWL FIRE FOR 30-VOLT CIRCUITS.

The latest pattern D.G./W. Bowl Fire is one taking 300 watts on a 30-volt circuit. It is built on similar lines to the D.G./W. Bowl Fire for 100-250 volts—a pattern which has now been on the market for upwards of five years—and has been developed to meet the needs of those consumers of electricity deriving their supply from small country-house plants.



The reflector is of aluminium, 5¼ in. dia., and the height of the fire is 9¼ in. The wire spirals, in grooves in the domed fireclay refractor, may be seen in the illustration, and as the reflector with the element is adjustable to any angle the fire may be used for heating, toasting, boiling, etc., similarly to the larger and higher voltage pattern.

Further particulars may be obtained from Drake and Gorham Wholesale, Ltd., 67, Long Acre, London, W.C.2.

ELECTRICAL MACHINERY IN THE MALAY PENINSULA.

In the past the amount of electrical plant that has gone to the Malay Peninsula has not been very great; but with the development of the industries of the country and its gradual opening up to civilised conditions there is reason to believe that its requirements of machinery of all sorts will increase. The statistics of the Straits Settlements show the value of imports and exports of electrical machinery for three years as follows:—

	Imports.	*Exports.*
1917	£60,525	£18,795
1918	£55,189	£22,191
1919	£153,590	£31,795

Though classified as exports, the electrical goods sent out of the Straits Settlements do not leave the Peninsula but find their way into the Federated and Unfederated Malay States—in 1917 to the value of £14,823, in 1918 £10,317, and in 1919 £22,818.

It will be interesting to merchants and manufacturers in this country to know whence British Malaya draws its supplies of electrical goods, and this is shown in the following table:—

	1917.	1918.	1919.
United States of America ...	£17,293	£9,179	£74,593
United Kingdom	28,569	17,028	50,430
French India	—	—	16,643
China	422	7,674	4,651
Australia	796	792	1,074
Italy	1,753	933	857
Japan	8,195	13,806	811
Hong-Kong	1,231	1,688	592

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The most remarkable feature of the above statistics is the supply of goods of this description from Asiatic countries, especially French India. The imports from Hong-Kong and the China coast ports may be merely transhipments from Japan, the United States or elsewhere.

In the Federated Malay States, the supervision of electrical machinery is entrusted to the Senior Warden of Mines, and from Mr. W. Eyre Kenny's report for 1919 it appears that the number of installations of generating plant in these States was as follows:—1917, 100 installations (8,976 kw.); 1918, 106 (9,360 kw.); 1919, 109 (9,544 kw.). In addition there were 20 self-contained lighting plants installed in private houses, plant to about 1,300 kw. was in course of installation at the end of 1919, the aggregate horse-power of motors employed was 9,320 as against 9,660 in 1918, and a census taken in December showed that motors totalling to 3,400 h.p. were available as spares, but were not connected.

A classification of all electrical generating plant employed in the Federated Malay States in 1919 was given in kw. as follows:—

	Power.	*Light.*
Mining	8,758 kw.	189 kw
Agriculture ...	68 ,,	216 ,,
General	110 ,,	146 ,,
Government ...	131 ,,	2,537 ,,
Total ...	9,067 ,,	3,088 ,,

The horse-power of motors employed for all purposes aggregated 11,560 as compared with 11,900 in 1918.

It is regrettable, writes Mr Eyre Kenny, that so many different frequencies and voltages are in use on mines. Mine-owners would be well advised to adopt British Standard frequencies and voltages. For three-phase power installations a frequency of 50 and a voltage of 400 or 500 at motor terminals will meet requirements in the majority of cases; for continuous current plant a voltage of 500 is in general use and may well be adopted. For lighting a voltage of 115 or 230 is practically in standard use in the Federated Malay States and the Straits Settlements, and although not British Standard it would be advisable to adhere to these pressures.

In the Malayan Collieries at Rawang, in Selangor, three new 300 kw. steam-driven generators were installed, a 98-in. "Sirocco" ventilating fan was brought into use, two storage battery electrical locomotives for underground use were imported and have rendered good service, and a long wall electrically driven coal cutter with an electrically driven coal conveyor were being installed at the end of the year.

In the report for 1919 of the Director of Public Works (Mr. R. O. N. Anderson) it is stated that the Gombok section of the Kuala Lumpur electric light installation gave a great deal of trouble during the year and there were many stoppages, the chief reason being the burning out of the generator coils. "It has been impossible to get new ones anywhere," wrote Mr. Anderson, "and there is no apparatus for carrying out repairs satisfactorily here," but doubtless this has since been remedied. Sale of current brought in £23,567, against £24,047, and the gross profit was £12,519.

Meetings.—An informal meeting of the Inst.E.E. will be held at the Chartered Institute of Patent Agents, Staple Inn Buildings, Holborn, W.C.1, on Monday, April 25, at 7 p.m. Subject: Discussion on "Engineering in Russia." To be opened by Mr. C. Lipman.

Canadian National Exhibition.—This exhibition, which is open to the general public, and combines the features of a trade fair and pleasure ground, will be open this year at Toronto from August 27 to September 10. Last year over one million persons visited the exhibition, so that wide publicity is afforded. Particulars from the Secretary, Canadian National Exhibition, 38, King Street East, Toronto.

MORE ABOUT TRAMWAY BREAKDOWNS.

By H. S. B. Robinson.

On all tramway systems the inspection and upkeep of the electrical and mechanical components of the car equipment is of far greater importance than any maintenance work on the system, as, if neglected, serious delay to the service is incurred, and in many cases an amount of energy consumption equal to that required for propulsion of the car would result and consequently cost more money than would have been spent in renewing the parts a dozen times. Moreover, the task is not a difficult one to accomplish, as all the working parts mentioned below are easily accessible for inspection and repairs.

Armatures.—Although numerous troubles in connection with armatures have been largely dealt with in a previous article, it should be remembered that sometimes motor burn-outs are difficult to account for, especially when failure occurs under normal working conditions. Probably in the case of old armatures the trouble is due to deterioration of the coil insulation or even to vibration of the coils. In the event of one of the motors developing such a fault, it should at once be cut out by raising the controller fingers, thus preventing contact with the main drum. The motor which is cut out is entirely disconnected and does not in any way interfere with the remaining motor, as no power is supplied to the latter until the controller handle is moved round to the first parallel notch.

Switches.—The majority of switches are automatic in action, and designed to break considerable overload current, which results in burning and blistering of contact fingers. This is probably the greatest cause of switch trouble and can be readily located by frequent inspection, though burnt and blistered contact fingers are more noticeable on some switches than others.

Brakes.—As the safety of the public is a matter with which tramway men dare not trifle, special attention should be given to the maintenance of brake gear, which is undoubtedly the most important part of a car equipment. The braking is carried out either by merely running the motors as generators on load through a suitable resistance or by using the generated current more effectively to actuate the magnetic brake; the rapidity and certainty of action can easily be ascertained from trials undertaken on an idle car. The braking effect varies with the speed of the car owing to the fact that the braking current is generated by the motors and that the greater the speed at the time of applying the brake, the greater the current supplied to the brake magnets, which should not be overlooked. The brake is normally operated by both motors, but should one of them fail, the other motor is still available for braking with the same effect as usually performed by both motors. Hand brakes constantly require adjusting and should be frequently inspected, and on undertakings where slipper brakes are employed it will be found that the wooden blocks require considerable attention.

Armature Bearings.—Considering the impossibility of preventing wear in the bearings and the trouble consequent upon any perceptible wear, the importance of lubrication cannot be over-estimated. The depth of oil

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in the reservoir can be easily gauged so that the most economical height is maintained, and although it has been found that these bearings will run for a fortnight before refilling becomes necessary, it is a better practice to adopt a regular system of oiling once a week.

THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

By Sir William Noble, M.I.E.E.

(*Continued from page* 210.)

The modern method of balancing underground cables which require to be loaded and to carry superposed loaded circuits was first applied to an underground cable in this country in 1913, when it became necessary to lay a composite telephone and telegraph cable between Leeds and Hull to replace the aerial wires which previously existed. This cable of approximately 52 miles in length was begun in June and handed over for traffic on November 23, 1913. This cable is interesting, inasmuch as it involved the making of over 90,000 capacity tests under field conditions, and because every individual mile of the cable throughout the whole route was balanced to a very high degree of accuracy. The cable without any modification or adjustment was found suitable for working simultaneously, without cross-talk or disturbances of any kind, loaded physical telephone circuits, loaded superposed or phantom circuits, and high-speed Wheatstone automatic telegraph circuits. A description of the system of balancing employed on this cable is beyond the scope of this paper, but it is fully described in one of the technical publications of the Post Office, which will shortly be available to members of the public by purchase from His Majesty's Stationery Office. In the meantime, copies have been supplied to the Institution Library.

Opportunity might be taken at this point of publicly expressing appreciation of the work of a recently deceased member of the Post-Office Engineering Research staff who made many notable contributions to the science of telephone speech transmission. I allude to the late Mr. Charles E. Hay. His work on the design of apparatus and methods for precision measurements by the alternating-current bridge was most valuable.

The programme of construction for 1914 included the provision of a main cable-duct route from London to Liverpool via Birmingham, and the first cable on this route was commenced in that year and completed as far as Birmingham in June, 1915, and extended to Liverpool in 1916. The cable was designed to give 30 circuits between London and Liverpool, and 42 between London and Birmingham and Birmingham and Liverpool.

The results obtained from this cable removed all doubts as to the future success of the underground trunk cable in relieving the congestion on the aerial lines, but it soon became evident that the very success of the first cable had opened up some new problems.

The quality of service afforded by this cable in comparison with that previously given by aerial lines led to a rapid increase in traffic between the centres connected by the cable. Not only were the individual circuits more "silent," i.e., free from the background of extraneous noise usually experienced on long aerial lines, but the whole groups of cable circuits between the respective centres were more reliable; they were unaffected by the adverse weather conditions which so frequently interrupt aerial lines in this country. Whereas a loss of 10 to 15 per cent. of working time was a common experience on long aerial lines, the loss on these cable circuits was nil.

On more than one occasion during the war period, when the Post Office engineering maintenance staff had been depleted to the utmost for service with the military forces, and interruption intervals on aerial line routes were unavoidably prolonged, the London-Liverpool cable saved the telephone trunk system from serious breakdown.

This was notably the experience after the extraordinary blizzard which caused so much havoc in March, 1916. I suppose that most of us have some knowledge of the effects of that storm, although the Press censors prohibited the publication of details at the time, but as the necessity for withholding facts has now passed, some description of the effects of this storm on the national communications may be of interest.

The storm swept across the country in a direction north-east to south-west, and reached a force of 75 miles an hour over a belt of nearly 100 miles in width between the Wash and the Bristol Channel. It reached the east coast about 7 o'clock on the evening of March 27, and was accompanied by a heavy fall of snow. Within little more than two hours practically every pole line inside that belt had been destroyed, and roads, railways and canals blocked with the poles and wires thrown across them. It was an unparalleled disaster in the record of the telegraphic and telephonic services of this country.

The main telegraph cables from London to the North saved the situation so far as that service was concerned, and the London-Liverpool telephone cable, with the spurs from Birmingham to Sheffield and Leeds, and from Liverpool to Manchester, enabled the engineers to patch up lines from London to all the important towns of the North Midlands and the North, and to keep them in telephonic communication with London at a time when such service was of vital importance.

Returning now to the consideration of the effects resulting from the success of this premier cable, it can be understood why, within two years of its completion, every available circuit had been allocated, and the question of providing a second cable arose. Three ducts had been laid along the route, this provision being in accordance with calculations of future requirements based on previous experience. It was evident that unless some new development in telephone enginering intervened, the duct route would be filled within a very short period. Moreover, the desirability of extending the underground system further north than Liverpool was apparent. The largest practicable main telephone cable has a diameter of about 2.0 inches and can contain copper conductors to a total weight of about 15,000 lb. per mile. Standard 176-yard lengths of this cable weigh about 2¼ tons net, and about 2¾ tons gross when drummed for transport. For direct service between two centres such as London and Liverpool, requiring lines having a transmission equivalent of 18 miles of standard cable (i.e. $\beta l = 1.926$) between terminal test-boards, such a cable will carry 25 four-wire cores or quads of conductors, providing a maximum of 75 circuits including phantoms.

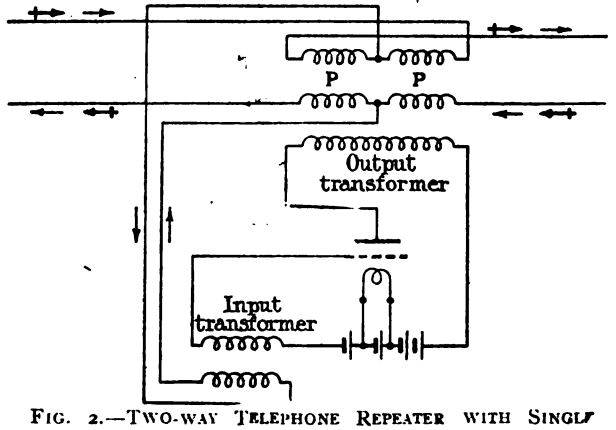


FIG. 2.—TWO-WAY TELEPHONE REPEATER WITH SINGLE AMPLIFIER.

(*To be continued.*)

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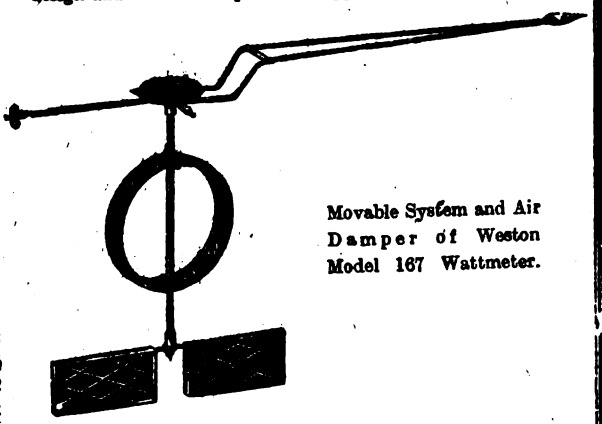
An efficient damper effectually prevents unnecessary oscillation of the pointer, thus permits readings to be taken on a violently fluctuating load, and, equally important, reduces wear of the pivots and jewels. If correctly designed it does not add appreciably to the weight or inertia of the moving system.

Its construction is one of the most complex problems in instrument design, and an air damper which effectually prevents all unnecessary oscillation of the pointer can only be produced by exceedingly careful workmanship.

It depends for its action upon the compression of air on the advancing side of the vane accompanied by the rarefaction of air on the receding side, and it is essential for proper damping that the resistance to leakage from one side of the vane to the other should be very great. Exceedingly small clearance is therefore imperative, and in WESTON instruments this has been reduced to the very low limit necessary.

A powerful damper may be easily constructed by increasing the radius of action of the damping vanes or their area, in which case larger clearance may be allowed. This course, however, increases both the weight and the moment of inertia of the moving system, and is bad design, but such construction being very cheap is almost universally employed.

Where reduced cost of manufacture is the primary consideration it is in details such as the above that inferior design and workmanship become apparent.



Movable System and Air Damper of Weston Model 167 Wattmeter.

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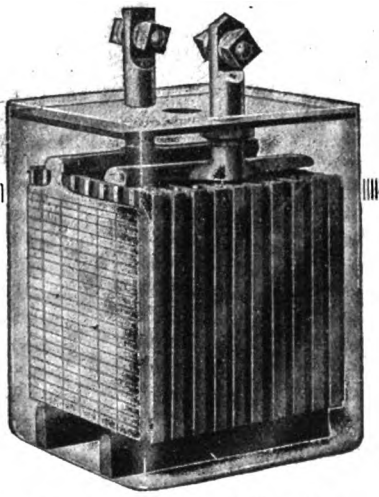
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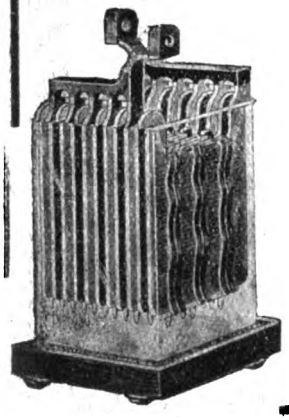
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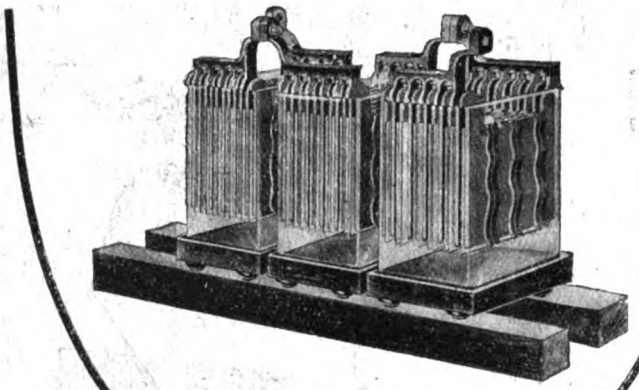
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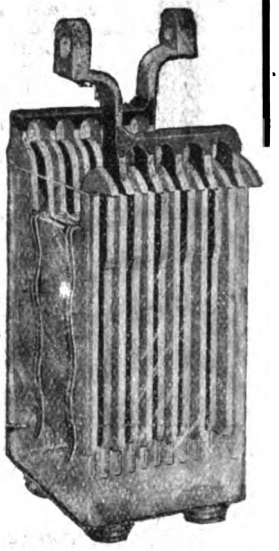
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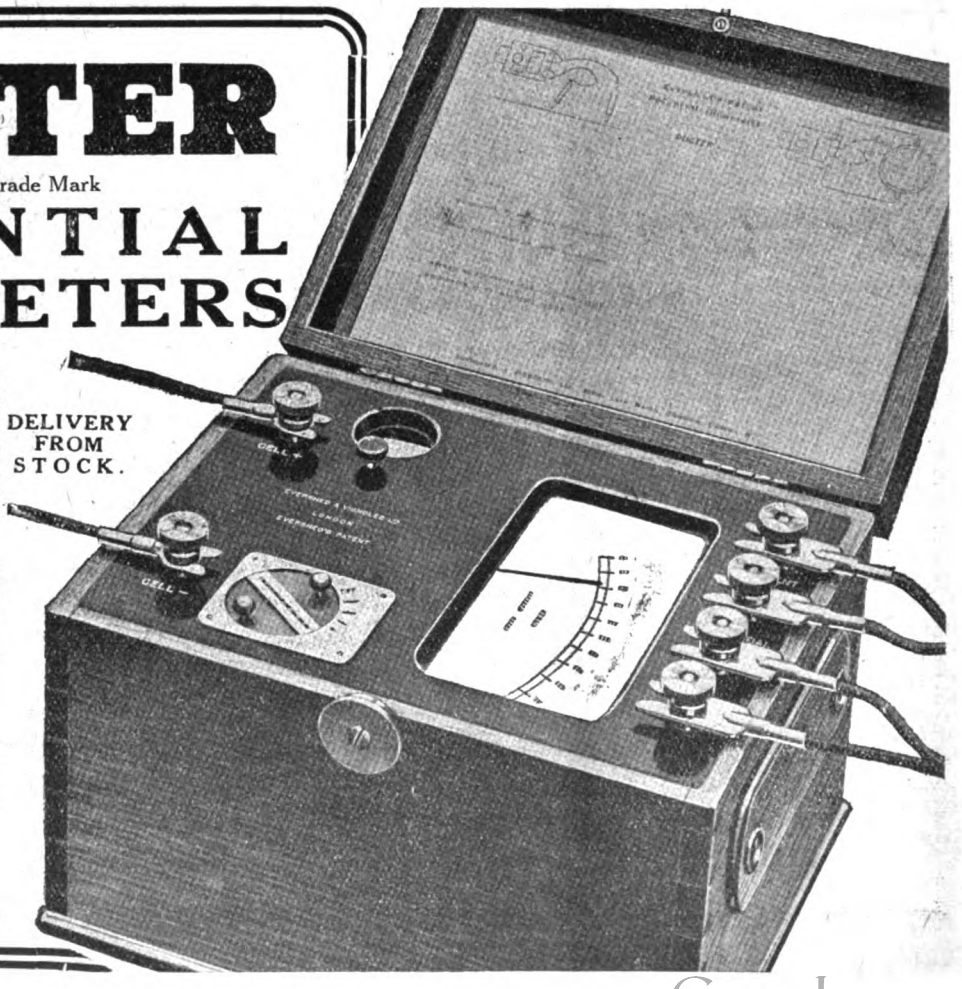
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Strike Reflections.

Each succeeding coal strike—and they follow one another at pretty frequent intervals nowadays—should serve as an additional stimulus to the imagination and inventive genius of those who have the national welfare at heart. Coal miners have their grievances, quite apart from the wages problem, and, admittedly, coal-getting is not a very attractive occupation nowadays. With the enormously increased demand, and the gradual extension of the underground workings as more and more tonnage is taken away from the more accessible seams, the difficulties and dangers of this occupation grow in proportion, and one wonders what will be the fuel of the future when coal, already so costly to obtain, is no longer available in sufficient quantities to yield an adequate return for the human effort expended in winning it.

Viewed in a general way, and making due allowance for the enormous strides in labour-saving appliances at collieries, coal-cutters, electrical haulages, electric pumping and ventilation, electric winding, electric lighting, and the hundred and one detail aids to coal mining in Great Britain to-day, the basic method of winning and subsequently handling this invaluable fuel is still crude in the extreme, as is also the general method of applying it to the needs of mankind. An eminent scientist's dream of underground power stations, with electrical power transmission from the pit-head, has not yet been realised. We still hew this mineral from its natural bed, working in cramped and unnatural positions; laboriously shovel it into primitive trucks, which are subsequently drawn by ponies to the bottom of the shaft, to be transferred thence by cage and winding gear to the surface.

At this point more laborious handling is involved in the screening, washing, and other operations before the already hardly won coal is tipped into coal trucks for its ofttimes lengthy journey to the point of ultimate consumption. Even when it reaches this point the task of labour is by no means finished, for it has to be transferred to coal bunkers, and, in the case of some older steam-generating plants, even stoked into the furnaces by hand, a shovelful at a time. Think of all the toil and moil involved in this lengthy series of operations before your coal reappears as energy in some form or another; light, heat, traction, power, etc. Consider also that, according to recent statistics, some 80 per cent. of the cost of getting it to the surface, in the first place, represents wages paid to colliery labour, and you begin to appreciate the intensely laborious nature of this occupation, not only of coal-getting, but of coal-handling, transportation, etc.

Small wonder that it breeds discontent; for there is little or no romance left in the modern handling and consumption of coal. All of which points urgently to the need for rapid and progressive development of those inventions, processes, and alternative sources of energy which, although they may not enable us entirely to dispense with coal, will in the long run reduce the demand and lighten the tasks of those who still gain their living by coal-getting. Contrast the process outlined above with that involved where ample water-power is available. Given the initial installation, a couple of dozen men are ample to control half a million horse-power. They could readily supervise the generation of as much energy as would necessitate the combined efforts of more than 12,000 miners in the hewing of coal for a year, to say nothing of the labours of the railway and other employees in converting it into electrical energy.

There is little doubt that the possibilities of future industrial peace depend largely upon revolutionary changes in our power resources and considerable limitation of our national dependence upon coal, either for internal industry or for export. Coal mining has become so speculative and costly a venture that in many districts it is no longer a paying proposition. Neither colliery owners nor miners are philanthropists, and some of the younger generation may yet live to see the day when coal, to-day a staple commodity in this country, has become a side-line. Already other countries are setting the fashion with vast hydro-electric schemes, and, although we do not possess the geographical advantages of some of our neighbours in this matter of natural water-power, it behoves us to take full advantage of every opportunity to harness whatever resources are available on the most modern and efficient principles.

Gas Lighting.

From coal to gas is but a step, and difficulties associated with the coal industry are inseparable from the allied gas industry. Like the carbon filament lamp, the flat-flame burner has long since become obsolescent, and incandescent gas lighting is the only recognised modern method. Notwithstanding this evolution, it is remarkable what a large number of flat-flame burners are still in use all over the country, in spite of their notorious inefficiency, and the consequent high cost to the unfortunate consumer. In this connection some interesting data is given by the Incandescent Mantle Manufacturers' Association. It appears that before the war, when coal was not stripped of the liquid aromatic hydrocarbons, a cubic foot of gas would yield with a flat-flame burner an illumination of from 3 to 4 c.p. Little enough in all conscience by comparison with electricity. The standard—i.e., the c.p. given by 5 cubic feet of gas with an Argand burner—was 14 c.p.

With the "stripping" of the hydrocarbons, a practice which is universal to-day, the residual gas is almost

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non-luminous when consumed in a flat-flame burner, and yields only ½ to 1½ c.p. per cubic foot, according to the thoroughness with which the stripping process is carried out. In view of the increased and increasing demand for benzol, toluol, etc., for motor traction, the dye and drug industries, it is safe to assume that the practice of thus stripping the gas of its luminous characteristics will continue and increase for some years to come. In the circumstances, gas cannot be economically employed as an illuminant without the aid of an incandescent mantle.

Consumed at an incandescent burner, gas, stripped to its lowest possible limit, and containing only non-condensable hydrocarbons, will yield an illuminating efficiency of from 15 to 20 c.p. per cubic foot, the precise figure depending upon the pressure and type of burner respectively. With gas at 20/10s pressure, and an ordinary upright mantle, the efficiency would be about 16 c.p. per foot; with a good inverted burner at 25/10s pressure, 20 to 22 c.p. per foot; while with a well-designed high-pressure burner, using gas at 3 to 4 lb. per square inch, the c.p. would reach 50 to 60 per cubic foot. The simple gas mantle thus makes it possible at its lowest efficiency to obtain fifteen times the illumination obtainable from any quantity of gas stripped of its hydrocarbons, and four times that obtainable from unstripped gas burnt under the most favourable conditions in plain flat burners. Incidentally, the above data discloses the very speculative nature of modern gas lighting as compared with electricity.

ELEKTRON.

A TYPEWRITER ATTACHMENT INVENTED BY A BLINDED HERO.

A device invented by Mr. Gamble (formerly an electrical engineer to a suburban corporation), who lost his sight in the war, enables him to undertake any kind of typewriting on any machine, and is worthy of being taken up for manufacture on a large scale in order to give other blind typists full control over their work. It would also be useful to those who have not had the misfortune to lose their sight.

The actual keyboard is, of course, memorised, and to help a Braille scale is fitted to the carriage of the machine in place of the ordinary printed scale. This scale is fitted with "stops" which operate a bell to give warning when the end of the horizontal line is reached. The chief difficulty, however, was found in easily determining when the end of the paper was being reached and in doing tabular matter, as well as in taking out a confidential document and reinserting it in exactly the same position. Some audible warning is obviously necessary, and the attachment (for which an application for Letters Patent has been lodged) gives this just the same as in working from left to right of each line.

It is made from an aluminium stamping, flanged at each side, and is trough shaped in section. Down the trough works a flat clock-shaped spring, its upper end being wound round the wheel at the top. To the lower end of the spring is fixed a clip somewhat after the shape of the office bull-dog clip, only instead of a spring to close the jaws there is a screw, so that the top end of the paper can be inserted, after it has passed under the typewriter roller, by the operator with the full use of both hands. On the clip is a projection for obtaining absolute squareness of the paper, and a tiny point sticks in the paper for determining the exact position should the letter have to be taken out and reinserted in the machine. With the spring and its clips holding the paper, typewriting can proceed in the usual way, and when the end of the paper is being approached the clip above referred to touches another stop with suitable trip-levers to operate a bell. The stops and clip are adjustable so that the exact position, working from top to bottom, can always be arranged for, thus permitting tabular matter to be done perfectly. Braille characters (marked out in inches) are stamped at the side, so that the parts can be adjusted according to the actual length of matter required.

The inventor's case is perhaps particularly sad. He resigned his position as electrical engineer to join the Royal Naval Divisional Engineers in 1914; subsequently after a very serious operation he was discharged as medically unfit. He then took up his old position, but felt that he was not taking his fair share of the country's obligations, and therefore offered his services to the Ministry of Munitions. He occupied special posts of importance with the Ministry, until finally he was nominated as chief electrical engineer to the National Steam Car Co., who were then engaged on the manufacture of steel castings for munition work. It was here that he met with an accident through the bursting of a coal calorimeter which deprived him of the sight of both eyes. This immediately prevented him from serious work. Sir Arthur Pearson took his case up, and in view of the circumstances was kind enough to give him an entry into St. Dunstan's, where he is at present training with a view to taking up secretarial work. It is a conspicuous fact that the Government have not found it necessary to furnish Mr. Gamble with any form of pension.

Mr. Gamble is very successful as a public entertainer and would be glad to receive engagements in this capacity also.

THE LIGHTING OF SMALL SHOP WINDOWS.

Although large stores have availed themselves of the benefits of scientific window lighting small traders have not as a general rule yet been persuaded to go in for an up-to-date system. Generally, they are content to substitute gasfilled lamps of high candle-power for the smaller lamps previously used—a futile proceeding unless correct fittings are employed.

Here and there one may see windows lighted adequately and artistically, and yet more rarely a small community of well-illuminated shops may be discovered. Such an aggregation may now, however, be seen at Palmer's Green, where Messrs. J. Prosper and Sons, the local electrical contractors, are lighting enthusiasts, itself a very useful basis for successful propaganda, and they have the further merit of recognising that practice is far more efficacious than precept. By equipping their own shop window with concealed X-Ray reflectors and Mazda Gasfilled lamps they persuaded in a few weeks twelve shops in the same block to install similar equipment. These shops include the following:—Toy shop, boot shop, outfitter, baker, draper, and music shop.

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Two shops of this brilliant group have been photographed. In both X-ray reflectors of the "Hood" type are used, each reflector being fitted with a 100-watt Mazda gasfilled lamp. The music shop, shown in Fig. 1, affords an excellent example of the

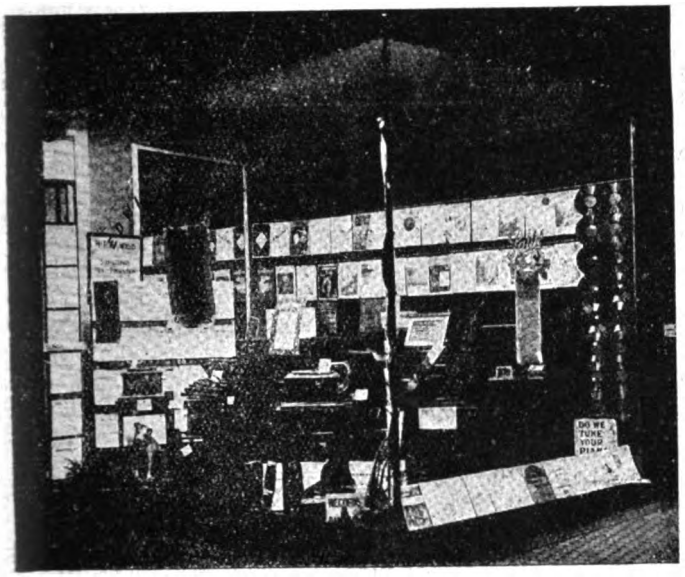


FIG. 1.

advantages of the system in highly trimmed windows containing tickets and other printed matter. As will be seen the music titles are clearly visible. Had the window been lighted in the ordinary way by means of lamps hanging in the line of sight the reflected light from the white surfaces of the music would have produced halation on the photograph, and the printed matter would have been quite illegible, which

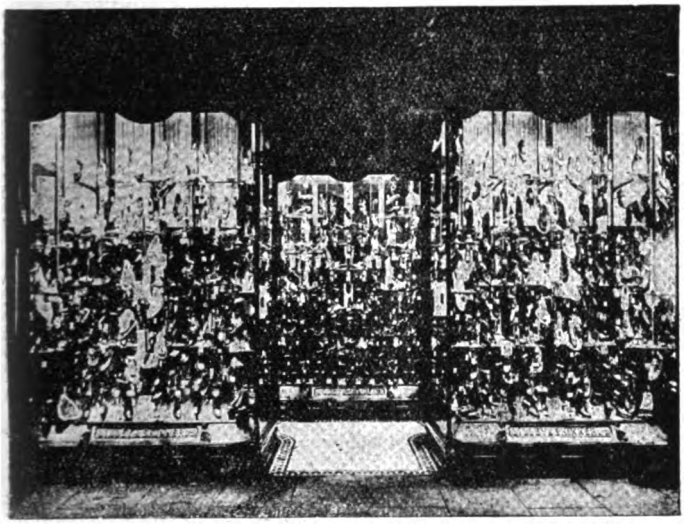


FIG. 2.

phenomena are simply a photographic exaggeration of the actual effects on the human eye. Four X-ray "Hood" reflectors and 100-watt Mazda gasfilled lamps are used in this window, the lighting units being concealed by a narrow curtain at the top. In Fig. 2, a boot shop, the window is similarly lighted, and here, too, the definition is quite good. It will be noted that, in spite of the close dressing, the illumination on the lower portion of the display is ample and well diffused.

Both photographs were taken at night, solely by the light of the X-ray units, and have not been retouched in any way.

The materials for all twelve installations were supplied to the contractors by the British Thomson-Houston Company's Illuminating Engineering Dept., (77, Upper Thames Street, E.C.4), to which requests for further information should be addressed.

TELEGRAPHY.

Being Solutions to the Questions set in the Final Examination in Telegraphy held by the City and Guilds of London Institute in April, 1920.

(*Continued from page* 218.)

Q. 9.—Describe, with the aid of sketches, the methods of binding-in bronze, copper and iron wire to the insulators. Why is it necessary to use different classes of wire for line conductors?

A.—For binding-in bronze wire to the insulators, a copper binding wire about three feet in length is neatly and tightly whipped round the line wire for a distance equal to the diameter of the insulator at the groove, and its ends are passed round the insulator in opposite directions, one over and one under the line wire, round which they are wrapped again for two turns. The ends are then passed again round the insulator in opposite directions and lapped tightly round the line wire on each side for another seven or eight turns. The method is shown in Fig. 1, in which the insulator is represented in section at the groove.

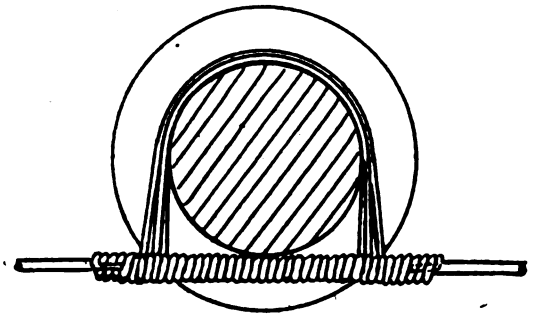


FIG. 1.

The method of binding a copper wire to an insulator is shown in Fig. 2. The line wire *LL* is first lapped

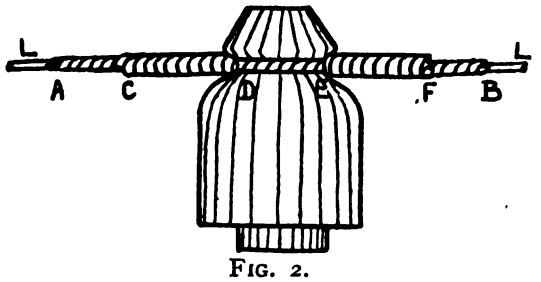


FIG. 2.

from *A* to *B* with *copper tape*, the width, length and thickness of which depends upon the gauge of the line wire. The *binder*, which consists of round copper wire of suitable length and size with flattened ends, is taken

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round the neck of the insulator, one end being bound round the served line wire in one direction from *D* to *C*, and the other end round the conductor in the opposite direction from *E* to *F*. The wrapping is done by hand, and the binder is tightened with the aid of rough-nosed pliers.

For iron wire the following method, illustrated in Fig. 3, is adopted. An iron binding wire, the size of

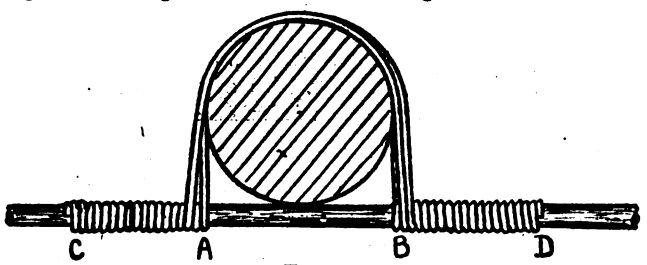


FIG. 3.

which depends upon the gauge of the line wire, is lapped twice round the line wire at *A*, and its inner end passed round the groove of the insulator to the under side of the line wire at *B*, and after one lap is taken back round the insulator to *A* and tightly lapped on the line wire for about a dozen turns to *C*. The other end of the binding wire is taken from the under side of the line wire at *A*, passed round the groove of the insulator to the upper side at *B* and similarly lapped on the line wire to *D*.

Although copper is decidedly superior to iron as a line conductor, the latter is the principal material used for aerial lines, owing to the high cost of copper. The iron wire used is thoroughly galvanised in order to protect it from rusting, and four sizes—viz., 200 lb., 400 lb., 600 lb., and 800 lb.—are employed. The light wire is used on short unimportant circuits, and the heavier wires on long high-speed circuits where the resistance of the line has a serious effect upon the speed of signalling; in the latter circumstances it is often necessary to employ 150 lb. or 200 lb. copper wire throughout the entire length of the circuit in order to get the required speed. Galvanised iron rapidly deteriorates in manufacturing towns and in districts near the sea coast; in such cases it is usual to employ 150 lb. copper on main lines and 100 lb. copper or 40 lb. bronze wire on minor lines.

Q. 10.—Give a skeleton diagram of the double-current duplex repeater and explain its working. Why is the automatic or electromagnetic switch used with the simplex repeater not required in duplex repetition?

A.—The skeleton connections for duplex repeater working are shown in Fig. 4.

The local circuits, the keys, leaks, etc., have been omitted for the sake of clearness, and the four compensation circuits have been denoted by *R*. The batteries are shown connected with the keys at rest, and it is assumed that the circuits have been balanced for resistance and capacity, as in ordinary duplex working.

When the keys are at rest, the path of the current is from the positive pole of the down office battery, through the *D*-circle *U*-circle coil of the down office relay, down line, *D* to *U* coil of the down side transmitting relay, *T* terminal of the up side transmitting relay, via the tongue, left half of the battery to earth, in at the right coil of the down office galvanometer to the negative pole of the battery. The path of the current in the down side compensation circuit is from the positive pole of the left half of the up side battery, through the down side compensation circuit, circle coil of the down side relay (direction *U* to *D*), to *T* of the up side relay, via the tongue and spacing contact to the negative pole of the battery. Thus, with the keys at rest, the down office battery and the up side battery combine to produce a current in the plain coils of the down side relay (direction *D* to *U*) twice the value of that in the circle coils of the down side relay (direction *U* to *D*); the tongue of the down side relay is therefore held against the spacing stop.

Similar remarks apply to the up side relay which spaces under like conditions.

When the key at the down office is depressed, the down

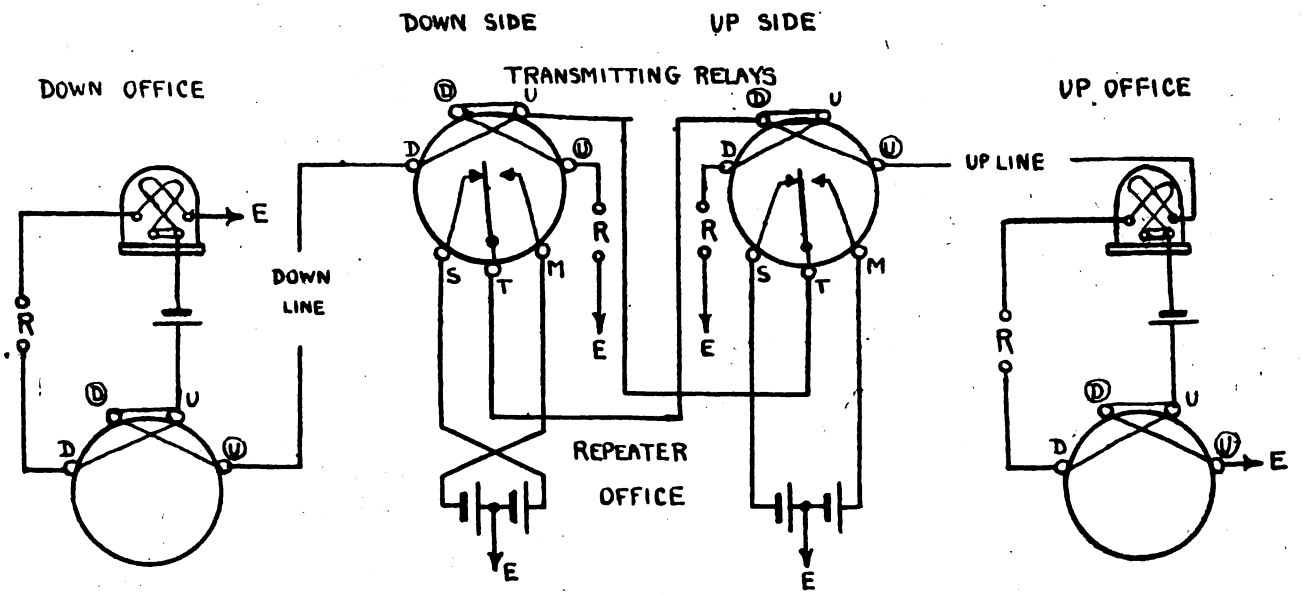


FIG. 4.

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office battery is reversed, and opposes the up side battery : no current therefore flows in the plain coils of the down side relay. The current from the up side battery, however, flows through the down side compensation circuit, through the *U*-circle *D*-circle coils of the down side relay, and causes a mark. Similar remarks apply when the up office key is depressed.

When both keys are depressed, the current is everywhere reversed in direction, and the line currents, being stronger than the spacing compensation currents, cause the relays to mark.

Thus the relays at the repeater office take the place of the keys, and transmit the signals to the terminal stations in the same way as if the receiving apparatus were connected directly in the same circuit as the keys.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision to final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers" or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 115.

Can any reader give me some information concerning the testing of steam turbines and generators?—"VACUUM."

QUESTION NO. 116.

I would appreciate full constructional details of a resistance which is to reduce 100 volts to 80 volts when a current of 5 amperes is passing for an indefinite period. How shall I wind the wire? Will mica or enamelled insulated steel tubes be satisfactory?; and what size and kind of wire is most suitable if the temperature is not to exceed 300 deg. F.? The resistance is to be enclosed in a flame-proof box, and the use of oil, for cooling, is prohibited.—"B."

(Replies to Questions Nos. 115 and 116 must be received not later than April 30, 1921.)

Correspondence.

PROPOSED ENGINEERS' CLUB.

To the Editor of ELECTRICITY.

SIR,—The proposal for an Engineers' Club in London is meeting with a large amount of enthusiastic support. Over 1,000 applications for membership have been received so far, and every post is adding to the number.

The greater the membership the easier will become the negotiations for suitable premises, and I ask those engineers who have not already done so, to send me their forms.

Full information and application forms can be obtained from me.

Some will have received duplicate forms, and for this I apologise, but a certain amount of overlapping is unavoidable.

Support to the movement is coming from every part of Great Britain, Ireland, and the Channel Islands, and applications are now beginning to arrive from overseas. Members are joining from South Africa, India, Australia, Spain, France, Holland, Norway, Belgium, Italy, etc.

If everyone will help, by joining himself and getting friends interested, the movement must be a success, and will give engineers throughout the world a fit and abiding home for the great profession that they represent.—Yours very truly, EDWARD L. HILL, Temp. Hon. Sec.

39, St. James's Street, S.W.1.

April 13, 1921.

TRAVEL SERVICE.

To the Editor of ELECTRICITY.

DEAR SIR,—Our managing director, Mr. E. H. Ellis, is leaving England on April 29 on a tour of our agents in North and South America, Canada, Australia, New Zealond, India and South Africa. In the past we have very much appreciated that an immense amount of doubt and uncertainty could have been saved if an unbiased opinion could have been given direct from the spot, and Mr. Ellis would be only too glad to give his services in this direction.

We feel confident that a large number of your readers would be glad to avail themselves of this offer, if you can see your way clear to mention it in your column.—Yours faithfully, CITY ELECTRICAL CO.

April 16, 1921.

Answers to Correspondents.

"TRANSFORMER" (Bath).—The details you send are not very clear, but we gather that you wish to know whether you could use your 25-volt lighting plant for electro-plating if your 6-volt dynamo breaks down. You may, but of course your plating baths should not receive a higher voltage than 6 volts. This involves the use of special resistances, the adjustment of which would have to be done very carefully or your work would be spoiled. The chief factor, however, to be considered will be the output, in amperes, of your 25-volt machine. If it is now almost fully loaded, then it will not be possible to take much power from it at a lower voltage without running the risk of breakdown. In reply to your question about transformers, these are not used on direct currents. The method of "converting" one direct current voltage to another is by means of motor generators.

Trade Notes.

Jennings, Ltd. (Pennywell Road, Bristol), timber merchants, sawing, turning and moulding mills, had two stands at the Building Exhibition at Olympia, where they showed a thoroughly representative collection of the extensive range of woodwork in which they specialise, electric casing and capping being one of the lines. A 270-page list of doors, joinery, woodwork, turnery, etc., will be send for 2s. in stamps or P.O.

McClure and Whitfield, Mersey Dynamo Works, Stockport, have appointed the **City Electrical Co.,** 1, Emerald Street, Holborn, their sole agents for Export, also for the following districts :—London and South-East Coast, 1, Emerald Street, Theobalds Road, London, W.C. 1 ; Lincolnshire : High Street, Scunthorpe, Lincolnshire ; the East Riding of Yorkshire ; Jameson Street, Hull ; the North-East Coast, 67, Grey Street, Newcastle-on-Tyne ; South Wales, 16, Charles Street, Cardiff.



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Various Items.

Social.—The staff of The Midland Electric Manufacturing Co., Ltd., have formed a Staff Social Club and held their first Dinner and Musical evening at the White Horse Hotel, Birmingham, on Thursday, April 14, when over 40 members spent an enjoyable time, W. L. Barber, Esq., Managing Director, presiding.

Transformers for N.Z.—The P.W.D. want ten single-phase oil-ccoled transformers for the conversion of hree-phase, 50-cycle current from 50,000 to 11,000 volts. Tenders with deposit of £100 by June 28, to Sec., Public Works, Tenders Board, Government Buildings, Wellington. Copies of Specification may be seen at Department of Overseas Trade (Room 59).

Dublin.—At the last monthly meeting of the Municipal Council, Alderman Shields moved the Electricity minute dealing with the Liffey's power possibilities. It recommended that the Council obtain an expert survey and report on the cost. Mr. Forrestal, in suggesting that the matter be held over for six months, said that this was a matter which should be taken in conjunction with the whole country. The future prosperity of Ireland would depend upon the harnessing of all the great rivers for electrical power. Finally, the matter was allowed to stand over as suggested.

Tenders Accepted.—The London County Council have recently placed contracts for electric traction lamps with the British Union Lamp Works, Ltd., Huyton Quarry, near Liverpool, English Electric & Siemens Supplies, Ltd., 38-39, Upper Thames Street, E.C.4, and Stella Lamp Co., Ltd., Winchelsea Road, Harlesden, N.W.10. They have also accepted the Tender of the Western Electric Co., Ltd., North Woolwich, E.16, for the supply of low-tension electric cables, etc., required in connection with the construction and reconstruction of the tramways from West India Docks to Mare Street, for the sum of £3,767 5s. 8d.

Railway Progress.—As mentioned in a separate paragraph, Sir William Forbes, General Manager L.B.S.C. Railway, recently distributed the certificates at the Crystal Palace School of Practical Engineering, and spoke of the development in the railway world during his 48 years' connection with it—he started at 16, in 1873. He was specially pleased with the results of electrification. They had been extraordinary—from 50 to 200 per cent. more passengers and the same increase of security. He was contemplating extensions of the system for suburban traffic, and possibly to the main line service, but the financial problem made it difficult to get on with the work at the present time.

Service Notes.—The following revision of the substantive scales of pay of certain grades of the electrical generating, etc., staffs employed at H.M. Dockyards and naval establishments at home is approved. Weekly rate for hired men :—Mains and distribution supervisor, 51s. to 60s. (for a working week of 47 hours) ; and "A" class station supervisor, 59s. 6d. to 73s. 6d. (for a working week of 55 hours, working in shifts). These rates are subject to the regulation deduction in the case of established men. For "B" class station supervisors and drivers and dynamo attendants, the revised rate is 47s. 10d.

Blackburn.—The Electricity Committee have received applications to extend the supply of current from their new station to Oswaldtwistle, Clitheroe rural district, Ramsgreave, Accrington and Samlesbury. The Committee are already committed to supply Great Harwood, Rushton and Darwen, and the new applications have been deferred.—Members of the Electricity Committee, accompanied by Mr. P. P. Wheelwright, electrical engineer, paid a visit of inspection to the new generating station at Whitebirk, on April 7. It is almost completed. —— The T.C. has decided to apply for membership of the E.D.A.

Urban E. S. Co., Ltd.—Although there was an increase in gross profit for the year 1920 over 1919, the directors are not recommending a resumption of dividend on the Cum. prefs. After meeting interest, debenture stock redemption and income tax there is an available balance of £27,163, of which £25,000 is allocated for depreciation and the remainder carried forward. The enlarged powers which the Electricity Commissioners and the Ministry of Transport are seeking to enable them to revise maximum prices irrespective of the limitations imposed by the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, have not yet been obtained, and consequently those undertakings which have been able to obtain only the inadequate relief afforded under the terms of that Act are still restricted thereto.

Lighting Plant for Serbia.—Two 40 kw. dynamos and 50 km. of overhead cable, etc., are required for the lighting of a town in Serbia (about 1,200 houses). Particulars from Department of Overseas Trade. The Serb-Croat-Slovene State is one of the countries to which the export credit scheme applies.

Faraday House.—As a result of the examination on April 12, 13, and 14, Messrs. H. G. Spencer (Erith County School), E. F. Smith (Emanuel School), E. W. M. Scott (Oundle School), and W. A. Bennett (Mundella Sec. School), have been awarded an Entrance Scholarship, Exhibitions and an Entrance Prize respectively.

Crystal Palace Engineering Society.—The "Wilson Premium," for the best paper read before this society during the past session, has been awarded to C. W. Carter, for his paper on "Reinforced Concrete." Other papers read during the session were "Time Recorders," by L. P. Floyd ; "Permanent Way," by E. H. B. Phillips ; "Locomotives of the L. and N.W. Railway," by C. F. Moore ; "Engineering of Antiquity," by E. G. Elton, and "Tunnelling," by D. M. Cameron. The Premium was handed to Mr. Carter by Sir William Forbes, General Manager of the L.B. and S.C. Railway, on the occasion of the 145th Conference of the Crystal Palace School of Practical Engineering, at which he presided on April 14.

Meetings.—The Annual General Meeting of The Electrical Trades Benevolent Institution will be held at the offices of the Cable Makers' Association, Sardinia House, Sardinia Street, Kingsway, W.C.2, on Monday, 25th inst., at 2.30 p.m. ——The Junior Inst. of Engineers will meet on Friday, 22nd inst., at Caxton Hall, at 8 p.m. Lecturette, "Construction and Working of Marine Water-tight Doors," by H. P. H. Anderson (Member). Slides. Also on Friday, 29th inst., at Caxton Hall, at 8 p.m. Discoursive Lecturette, "Rambling Remarks on Expert Evidence," by W. A. Tookey, M.I.Mech.E. (Member). And on Friday, May 6, at Caxton Hall, at 8 p.m. Lecturette, "Fire Resistance of Aggregates for Reinforced Concrete," by D. W. Wood (Associate).

Marconi in Peru.—By agreement with the Peruvian Govt., Marconi's Wireless Telegraph Co., Ltd., will, on May 1, take over and operate for 25 years the whole of the postal telegraphic and wireless services of Peru, receiving as remuneration 5 per cent. of the gross receipts of the services and 50 per cent. of the annual profits. Sir William Slingo, late Engineer-in-Chief of the British P.O., who was commissioned by the Marconi Co. to examine the Peruvian postal and telegraph situation, has now accepted the position of Chief of the Peruvian Postal and Telegraph Dept., and will act in this position on behalf of the Marconi Co. The postal and telegraphic conditions in Peru are of interest as some of the 9,000 miles of telegraph communications exist at a height of 16,000 ft., notably where crossings are made of the Andes.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
APRIL 29, 1921.

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HINTS ON LOCALISING AND EXPEDITIOUS METHODS OF REPAIRING FAULTS IN COLLIERY A.C. PLANT.*

By E. Cunningham.

At the present time, when everything connected with collieries is being reviewed, with the object of increasing the production and output of coal, and a fair percentage is lost annually due to stoppages of electric plant caused by breakdowns, faults, etc., it is up to us to think out and devise methods to reduce this percentage to a minimum.

We mostly all know from experience how many valuable hours may be lost in tracing a small defect in some electrical apparatus; the writer puts forward a few hints which he thinks would save much time and also might be the means of bringing out other points and suggestions which may be of value to the members.

In the first place, when the electrician receives the message regarding the fault or breakdown it is usually very vague, and the question arises as to what are the necessary tools, material and testing instruments required to carry out the repair.

Portable Repair Outfit.—If the motor or apparatus is situated at a considerable distance from the pit bottom any risk of having to come back to the surface for tools, etc., should be eliminated as far as possible. Therefore when the electrician receives a call to a breakdown underground, he should take with him:

1.—A good selection of tools;
2.—Insulating materials such as mica, leatheroid, etc., which would be useful for making insulating washers and bushes or for putting between coils in the event of a short-circuit. Also insulating tapes for repairing cable connections;
3.—A few spare brushes if the motor is a slip-ring type, also finger tips and barrel contacts for the control gear;
4.—A small box containing an assortment of small screws, nuts, washers and odd springs suitable for brush holders, etc., also various sizes of fuse wire;
5.—Testing instruments. The usual ones are the megger and galvanometer; the latter is the most popular one, as it is much lighter to carry underground.

* Paper read at a meeting of the Lothians Branch of the Association of Mining Electrical Engineers, Edinburgh, on November 27. With acknowledgments to *The Mining Electrical Engineer*.

In the writer's opinion a good substitute for the megger or galvanometer and one which has a wider scope of usefulness in fault testing, provided the supply voltage is not more than 500 volts, is a portable form of test lamp or lamps.

This should take the form of batten holders fitted to a good strong wooden box, the connections from holder or holders should be connected to two terminals inside the box. From the same terminals two single core rubber insulated flexible cables are taken through holes in the box, the ends of these cables should be connected to two rigid copper wires on which strong insulating handles have been fitted. A large insulating washer at the ends of the handles would act as a guard and prevent accidental contact with the copper points. A cover could be fitted over the lamps to protect same from damage in transit. A test lamp constructed on these lines could be handled with safety.

Carbon filament lamps should be used as any variation of the voltage is easier detected by the eye than would be the case using metallic filament lamps. When the electrician proceeds to locate a fault he should use common sense reasoning and look at the situation not only from his own point of view as an electrician but also from that of the manager who is responsible for the output of coal.

All tests should be carried out systematically so that no electric plant is stopped unless absolutely necessary and then only for the shortest possible time; also nothing should be taken for granted.

Cables.—The manufacture of cables has been brought to such a high state of efficiency that one seldom hears of a breakdown in the insulation unless it has been caused by the following: Mechanical damage to the armouring; water getting into joint boxes (that have not been filled in with bitumen); or heat from an external source affecting the condition of the insulation. In most cases a physical examination of the cable will usually show where the fault has taken place; if it be found damaged at a certain part and the cable is the main feeder for a section of the pit, the electrician must isolate the defective part of cable as quickly as possible and so allow the other motors in the section to continue working. To illustrate this point we will take a sketch (Fig. 1) of a supposed feeder for a section of the pit, and the cable has been damaged at X, causing a short-circuit. This will necessitate cutting and laying back the armouring so that the cores can be reinsulated and then a joint box fitted on and filled in with bitumen. Now this would probably take from four to five hours, and the whole section stopped until the repair was effected. If in the other case the cable had been disconnected at E this would have allowed the other part of the section (A, B, C, D) to get working. The damaged part could then have been repaired and a joint box fitted, and the final connecting up at E could have been carried out between shifts.

In the case of a short circuit in a cable that cannot be located by physical examination we decide to break the cable

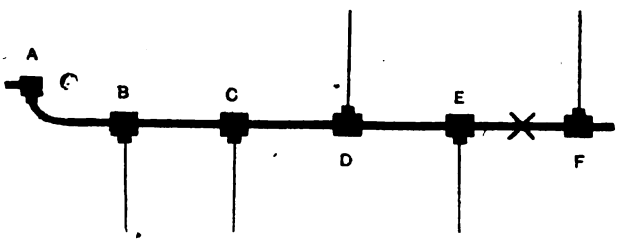


FIG. 1.

into sections. We will take the same sketch and X will represent the fault we are trying to find. Now if we break the connections at D and try the circuit-breaker at A we would find that the cable is clear up to this point and therefore we have confined the fault to half the total length of cable. We could reconnect at this point, as we now know that the fault lies between the points F and D. We would then take the nearest point midway between F and D which would be E and disconnect. On trying the circuit breaker at A we would find that the cable was still clear up

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to this point and the fault would then be confined to a section, the length of which would only be a quarter of the total length.

As this section could not be split up any further it would be kept isolated and so allow the other plant in the section to continue working during the time it would take to locate and repair the fault in the section E F.

In testing shorts in cables some might take exception to the method of using the circuit breaker but it is a convincing one, whereas in testing with the megger or galvo. one can be badly misled by some minor circuit across the mains, such as a voltmeter fixed in a remote part of the circuit.

To locate a fault in a cable that does not show any outward signs of damage the writer gives details of a test he applied and which proved very successful.

A short-circuit developed between two cores of a 3-core 37/15 swg. d.w.a. vulcanised bitumen cable installed in a vertical shaft 120 fathoms in depth. The cable was in one continuous length. On the surface the lighting was taken from a 200 volt D.C. generator. Two leads were taken from this generator and connected to the two faulty cores, a water resistance was inserted in one of the leads. The resistance was adjusted until 25 amps. flowed through the short-circuit in the cable when the D.P. switch was closed.

A surveyor's dial compass was held quite close to the cable where it entered the shaft at the surface. When the D.P. switch was closed the needle swung round and pointed to the armouring of the cable; when the D.P. switch was opened the needle turned round to its original bearing. This test was repeated every two fathoms down the shaft until a point was reached when no movement of the needle took place when the current was switched on and off and it was possible to get a part of the cable where a movement of the compass a distance of six inches up or down made the needle deflect or remain stationary when the current was switched on. The time taken to locate this fault was one and a half hours. When the cable was opened up the fault was found at the part indicated by the test. The cores were reinsulated and a joint box fitted to this part of the cable and the repair completed in 18 working hours.

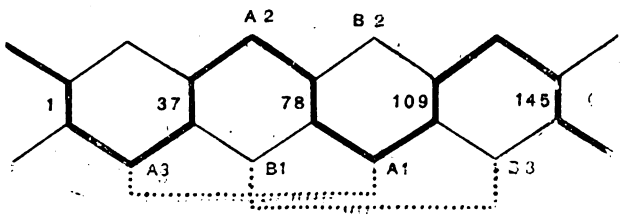


FIG. 2.

Slip-ring Motor and Control Gear.—When the electrician proceeding to a fault on a motor has to pass on his road inbye the distribution panel with the feeder for this particular motor, he should examine this and test with the lamps to prove whether the supply to the feeder is correct or not. Otherwise he may pass this panel and find on testing at the motor end that the fault lies at the distribution end; the distance between the two points may be considerable. When he gets to the motor house he should give the attendant a fair hearing as to what has taken place, as very often an observant attendant can save the electrician a great deal of time and trouble, but where possible the electrician should confirm the attendant's statement by seeing what actually takes place for himself.

Short in Rotor Circuit.—This circuit consists of the rotor winding, slip rings, brush gear and resistance elements. If the brushes are lifted off the slip rings, and then the circuit breaker put in and the controller handle moved to the first step, should the motor start up this would show the fault to be in the rotor winding or in the slip rings. Should the motor fail to start up this would prove the rotor winding and slip rings probably to be in order; the brush gear could then be isolated and tested and so on until the fault was located.

Broken or Bad Connection in Stator Circuit.—This circuit consists of the stator windings, controller and circuit breaker. An examination of the controller should be made first, as this would be a likely place for this fault to happen. Should this show no result the three cables at the stator terminals should be disconnected and kept apart. The circuit breaker could then be put in and the controller handle moved to the first step and the three stator cables tested by means of the test lamp. If the lamp showed a full glow between A and B phases and B and C phases the fault would be in the stator as this would prove that the supply was correct to this point. If the lamp failed to light or only gave a red glow across two phases the next point to test would be in the stator, as this would prove that the supply and if this still showed a fault the three incoming mains to the circuit breaker could be tested; if these showed by test to be correct the fault would be probably in the circuit breaker.

Coal Cutters.—On the road inbye to a fault the gate-end switch could be tested with the lamp and the circuit proved up to this point. With the gate-end switch in, the pommel could be withdrawn from the machine and tested with the lamp, this would prove the trailing cable.

Then with pommel entered into the machine and the machine starting switch in "off" position, the live side of this switch could be tested. This would prove the circuit up to the stator cables.

Repairs.—When the fault has been located the next thing is the quickest possible repair to keep the motor running until the winding shift is finished, always provided the repair will not take longer time than it would to replace the motor or switchgear. In the case of an earth in a stator winding due to a breakdown in the slot insulation, if the earth is on the one slot only this slot should be isolated by altering the end connections, or if necessary the whole coil should be isolated. If in another case it was a coil short-circuiting between turns and forming a closed circuit in itself the coil or slot should be isolated as in the first case and then all the conductors cut to make an open circuit: otherwise the alternating flux in the core would generate heavy currents in the coil and the heating effect of same would damage the insulation.

Typical Repairs.—The writer gives details of some repairs he has carried out, to illustrate what can be done to keep electric plant running until such times as it can be replaced or permanently repaired without loss of time and output.

A short circuit developed in the rotor of a 150 h.p. 3,000 volt motor driving an endless rope haulage drawing a main dook.

The total weight of the motor is 3 tons 15 cwt. The rotor is a bar wound type with soldered joints at both ends.

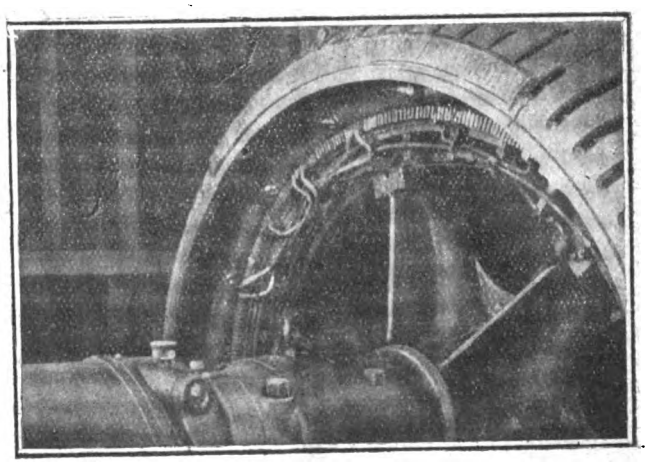


FIG. 3.

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Dimensions of rotor: Diameter 4 ft. 6 in.; width across the winding, 22 in.; number of slots in rotor, 360; number of bars per slot, 2; number of slots per pole per phase, 6; speed 300 r.p.m.; periods 50; 20 pole winding.

The short circuit took place in two adjacent slots between top and bottom bars and earth, both slots were in the one phase.

To draw this rotor and move it to the surface would have taken at least two shifts, and if the faulty bars had been replaced the repair would have taken from 10 to 14 days. At least one-fifth of the winding would have had to be disturbed to get the old bars out and new ones in as in this type the bars are put in from one end and then bent to the step of the winding. The diagram (Fig. 2) shows a section of the winding equal to 4 poles, and one bar per pole per phase, and one phase only, for clearness. As it meant a big loss of time and output to replace the bars it was decided to isolate the two slots.

Slot No. 73 on the diagram represents one of the faulty ones; we have two conductors, one top and one bottom, in this slot which had to be isolated and the continuity of the phase maintained.

The top one is connected to a bottom bar at B1 and B2, so that if we isolate the bar at these points we would have to run an external connection between B1 and B2. As this meant passing a connection from one side of the winding to the other, through the spider, rather than do this it was decided to isolate the bottom bar in slot 109 which is the one connected to the faulty bar. A cross connection was then run from B1 to B3 as shown by the dotted lines. The bottom bar in slot 73 was isolated in the same way by isolating the top bar in slot 37 and cross connecting A1 and A3.

The other faulty slot not shown in diagram was isolated by the same method. Fig. 3 shows the repair connections on the rotor winding.

The actual time taken to carry out this repair was nine hours; it was done about seven months ago and the motor is still operating satisfactorily.

(To be continued.)

CINEMATOGRAPH STUDIO LIGHTING.

GASFILLED v. ARC LAMPS.

The gasfilled metallic filament lamp is rapidly growing in favour as an illuminant for portrait studio lighting, but its use in the production of cinematograph films has not yet been extensively developed. An account of some experiments in this direction recently made with Osram Gasfilled lamps in the studios of Messrs. Holams, Ltd., may therefore be of interest.

The orthochromatism of modern films, by which colours are given their true relative tone values when exposed in daylight, is of little advantage when the exposure is made under arc lamps emitting a predominance of blue and blue-violet rays. In the gasfilled lamp, however, the photographer has a light source rich in red, orange and yellow rays. Thus the resultant light is a closer approximation to daylight than that often used and the images on standard orthochromatic film are more colour-true.

In the tests mentioned above, a large number of models and colour schemes were photographed, and it was found that it was necessary for the artistes to use little or no make-up other than that necessary for special character effects.

The two illustrations reproduced are sections of films of the same scene taken on the same day under exactly identical conditions, the one under arc lamps and the other under the light from Osram Gasfilled lamps. The colour scheme was purposely made as rich and comprehensive as possible so as to present a really difficult subject. The background consisted of three panels—in the centre, an Indian rug having a warm pattern of red, yellow, green and blue. The side panels were of rose red velvet and black and yellow striped silk respectively. The sitter was also a somewhat difficult subject, being fair, with light brown hair and blue-grey eyes. Her dress was of natural Shantung with navy-blue collar and cuffs. Fig. 1 was taken with 12 enclosed arc lamps, taking 15 amps. each at 200 volts, a total of 36 kw. Fig. 2 was taken immediately afterwards, with 16 1,500 watt Osram Gasfilled lamps in G.E.C. studio reflectors, and consuming in all 24 kw.

The results of these experiments tend to show that the gasfilled lamp is worthy of playing a much larger part in film production than hitherto, from the point



FIG. 1.



FIG. 2.

of view of film quality alone. They have, however, other inherent advantages, e.g., they are very light and easily handled so that replacements can be made quickly. Moreover, the absence of complicated mechanism makes for simplicity of operation and low cost of supervision and maintenance, a small staff of electricians only being needed for the largest installation.

Gasfilled lamps are obtainable for all standard voltages and are suitable for both A.C. and D.C., so that no energy is wasted in resistances and no converters are necessary. Other valuable features are that the quality of the light does not vary appreciably throughout the life of the lamps, reaches its full value immediately the lamp is switched on, and is perfectly steady.

Finally the question may arise as to the dazzling

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effect of the intensely brilliant gasfilled lamps, but if these are installed with large white reflectors behind and suitable diffusers in front the glare is not any greater than that of the usual arrangement of arc lamps.

MERSEY AND WEST LANCASHIRE ELECTRICITY DISTRICT.

The first decision to be made known by the Electricity Commissioners in connection with an "Electricity District" has just been announced, and is therefore of interest.

As a result of the recent inquiry at Liverpool into the two schemes submitted respectively by the Conference of Mersey and West Lancashire Electricity Authorities, and by the Corporations of Wallasey and Birkenhead, the Commissioners have decided that (1) the area provisionally determined is confirmed subject to the inclusion of the urban districts of Lymm, Haydock, Northwich, Middlewich and Winsford, and the rural district of Northwich. (2) A joint electricity authority will be formed for the whole district. (3) The advantages to the local authorities of the Wirral peninsula of independent combination will for some years outweigh those of inclusion in the scheme for the whole area. Subject to liaison with the joint electricity authority, a separate committee will be established representative of the local authorities for the following districts, namely, the County Boroughs of Birkenhead and Wallasey, the Urban Districts of Hoylake and West Kirby, Bromborough, Higher Bebington, Lower Bebington, and Neston and Parkgate, and the Rural District of Wirral (called the "Wirral Area"). It may, however, be found advantageous to merge the Wirral committee in the joint authority at some future date. (4) A capital station in the neighbourhood of Liverpool, and a transmission system connecting it with Liverpool, Bootle, Prescot and St. Helens is immediately required, and will be of advantage to the neighbouring districts. (5) The fullest and most efficient use should be made of the generating plant of the Mersey Power Co., Ltd., who may be empowered to extend their operations by bulk supply or otherwise into neighbouring districts. The company will have separate representation upon the joint authority, to which it will elect one member. (6) The areas of the Wirral Committee and the Mersey Power Co., Ltd., should in due course be linked up with the remainder of the area.

The Commissioners have accordingly decided to prepare a draft Order to cover the above findings, providing (*inter alia*) for the joint authority and the Wirral committee respectively being required to submit, within a period of two years from the date of their formation, proposals for giving or securing a supply in unoccupied areas where there is a reasonable prospect of such supply being remunerative. Also, for the administrative expenses of the joint authority being met by contributions from each of the interests represented on the authority, and for any deficiency on revenue account which may arise from the supply of electricity being, by a readjustment of charges or otherwise, met only by those undertakings which are connected with the joint authority's transmission system; as well as for the necessary financial powers being conferred on the joint authority and the Wirral committee, subject in the former case to the enactment of the Electricity (Supply) Bill recently reintroduced before Parliament.

Pending the establishment of the joint authority and the Wirral committee, the Commissioners will ask the parties concerned to form two small provisional committees with whom the Commissioners may consult from time to time with regard to any development of supply in the electricity district and the Wirral area respectively.

The observations of the parties represented at the recent inquiry will be invited on the clauses of the draft Order before the Commissioners hold the further inquiry required by Section 5 (4) of the Electricity (Supply) Act, 1919.

THE ELECTRIC HOME.

How to Get it Appreciated.

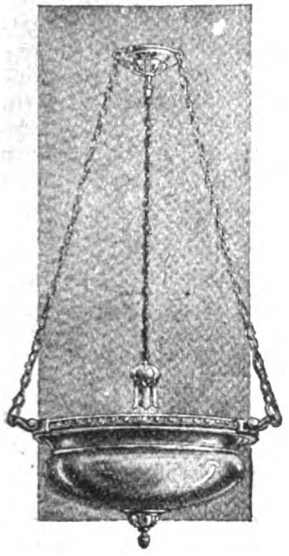
At the present time it is difficult in many districts for electrical engineers to deal with the amount of general business which is offered to them, and to seek new connections may remain difficult for some little time. There is, however, evidence to show that the use of small electrical accessories is not being pushed as it might be, though it will generally be found that additions can be made with these accessories without appreciably affecting the position of the supply undertaking, either in regard to station, mains or metering.

Domestic accessories offer two advantages. They bring in a revenue which in the aggregate is worth having, particularly as much of it is secured at lighting rates, and, therefore, the average obtained lies between the local heating and lighting rates. The other and perhaps greater advantage of pushing these appliances lies in the fact that they give satisfaction to the users, provide them with conveniences which otherwise they could not enjoy at all, and gradually lead them on to the fuller use of electricity in the home. Flat-irons, kettles and fans, and also suction cleaners, in fact, prove the best of all missionaries or canvassers for the electric home, as presented in two attractive booklets, "Woman's Work is Never Done" and "The Home of 1921," produced by the Electrical Development Association. Both are admirably conceived and executed, and could be used with advantage by the electrical supply industry.

A NEW PROJECTION LAMP.

A projection arc lamp using larger currents and smaller carbons than usual is described in recent issues of *Zeitschrift für technische Physic* and *Central-Zeitung für Optik und Mechanik*. The lamp is of the Beck type, manufactured by Messrs. C. P. Goerz, and the dia. of the carbons has been reduced to .44 times that of the older type, the area being reduced to about .19, with the result that a surface brightness of 1,260 candles per sq. mm. of the cross-section of the carbons has been attained. This is seven times the surface brightness of ordinary arc lamps, and twice that of the previous Beck type of lamp. In a comparison experiment it was found that the Goerz-Beck lamp using 25 amps. gave a projection picture of the same brightness as an ordinary lamp using 50 amps. The new type of lamp is specially suited for the projection of autochrome pictures. (*Technical Review.*)

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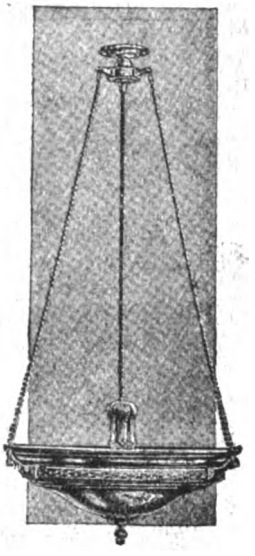
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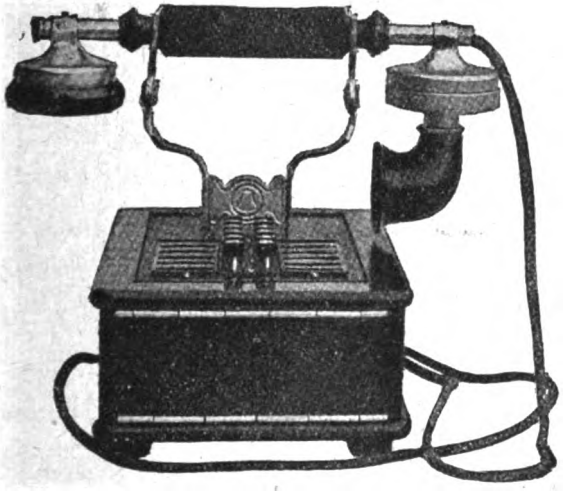
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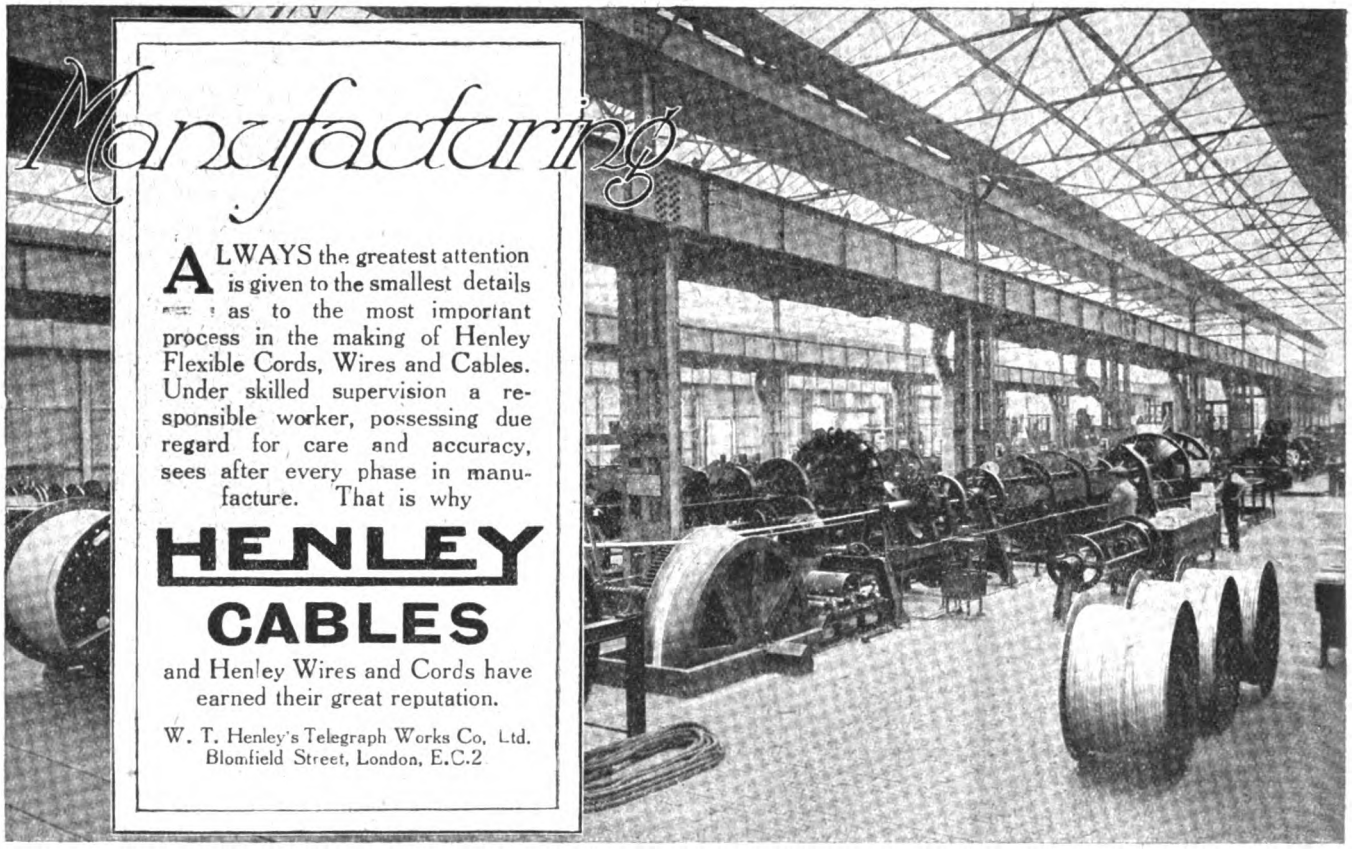
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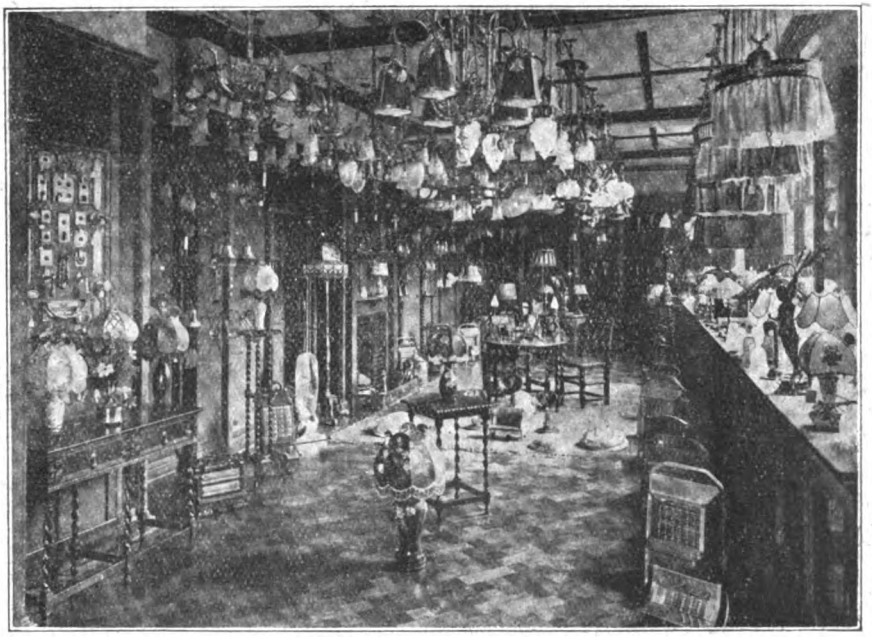
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Long-Distance Telephony.

The recently reported 5,500 miles telephone conversation, although a typical American "stunt," is, nevertheless, of historical interest as demonstrating what the future may hold in the way of trans-continental and international telephony. Given the necessary organisation, apparatus, and suitable cable connections there is now practically no limit to the possibilities of telephoning half round the world. Wireless can bridge the gaps left in air and cable routes, whilst the thermionic valve repeater provides the necessary additional energy at intermediate points to boost up the initially feeble telephonic currents. It must not, however, be inferred that these facilities for long-distance telephony will soon be available to all telephone users who care to pay the special trunk fees, which would have to be very heavy indeed to cover the enormous cost of such an organised scheme as that above referred to.

It is a comparatively simple, though expensive, matter for a powerful organisation like the American Telephone and Telegraph Company to prearrange a set of conditions along its various air line and cable routes extending across the Continent so that theoretical possibilities, worked out in the laboratory in detail, can be put to actual test as indicated. Such an experiment involves whole-hearted co-operation between all the responsible officials along the route, and a good deal of preliminary experimental work at the various links to ensure success on the date fixed for the demonstration. Great credit is due to Colonel Carty, vice-president and chief engineer of the company, and his staff of assistants for their achievement, and when in later years, perhaps, we speak in London to our friends and business confrères at Johannesburg, Bombay, or Hong-Kong, we shall have the A.T. and T. to thank for the inception of the idea.

Incidentally, it is interesting to record that the final link in the longest telephone circuit was that between Florida and Havana in Cuba, consisting of submarine telephone cables 100 miles long. The Cuban telephone service is itself a worthy example of modern telephonic progress. It is automatic for the greater part and serves some 239 cities. Since the introduction of automatics the Cuban Company has progressed by leaps and bounds, no less than 2,800 additional lines being installed as recently as last year. Moreover, its telephone service is run at a gratifying profit, the preference dividend being 6 and the ordinary 8 per cent., whilst the rates are by no means high for the service given, which is generally acknowledged to be excellent.

Liquid Fuel.

Having regard to the intermittent character of coal supplies, and the prevalence of the strike habit, the recommendation of Mr. Barr, the Swansea Electrical Engineer, to fit oil burners to the boilers at the generating station for use in such emergencies as the present is worth consideration by other power station engineers. With the modern development of oil firing in steam raising plant, oil burners can be quite readily fitted to most modern boilers and kept in reserve. Although the Swansea suggestion arises in the first instance out of coal bunkering limitations, it is quite a good notion; oil is readily obtainable except during transport strikes, and in any case is less difficult to transport and occupies less space than solid fuel. A power house equipped for either fuel should stand a far better chance of "carrying on" in an emergency than one equipped for coal burning only.

Anomalies of Engineering Progress.

It is characteristic of the topsy-turveydom of scientific progress and the evolution of engineering that the advantages we enjoy to-day cost us more than if we had made good use of them in the earlier pioneer periods. Thus, in the early days of motoring the owner of a Minerva motor-bike or a Benz or De Dion Car was able to tour the country to his heart's content on high-grade petrol at 10d. to 11d. per gallon. Nowadays, in a far more efficient vehicle from the fuel-consuming standpoint, he is mulcted at every turn for petrol, oil, taxes, licences, fines, and all the other expenses incidental to progress.

Similarly in the good old days when electricity was cheap, thanks to reasonable coal prices, it was possible to run all kinds of domestic labour-saving devices—had they existed—at a purely nominal expenditure for energy. Unfortunately electric vacuum cleaners, flat-irons, radiators, knife cleaners, washing machines, etc., did not exist when electricity was cheap, and, now that the designers and manufacturers of these attractive devices have shown what they can do in saving household drudgery, the basic energy for operating these appliances has risen to such a figure as to render the cost of operation almost prohibitive.

It would appear that the old law of supply and demand is ceasing to apply under modern conditions. What is the good of engineering progress if it does not ultimately lead us to a cleaner, healthier, and less laborious existence than heretofore? Necessity is the mother of invention and most labour-saving inventions are the outcome of some intelligent brain's activities aimed at reducing manual effort and making life easier for the individual. The development of domestic electrical appliances is the direct outcome of the practical disappearance of domestic help. The modern girl shuns domesticity like the plague, and as a natural consequence the average wife and mother is left to shift for herself.

This is placing a very unfair burden on the modern housewife which the recent development of domestic

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labour-saving appliances was intended to counteract. What, for example, could be a better method of removing dust and dirt from interiors than that underlying the action of the electric vacuum cleaner? Our grandmothers' practice of first sweeping the floor, and then dusting the furniture, simply resulted in a displacement of the dust from the floor to the furniture and its subsequent redistribution about the room. An inefficient process at best, and very laborious as carried out in Victorian days. The electric vacuum cleaner sets about the job in a scientific way. It not only dislodges the dust and dirt, but actually removes it from furniture, carpets, curtains, etc., and deposits it in a dust-tight receptacle whence it can be emptied into the dust-bin, quite outside the premises.

In spite of this wonderful improvement in method, and the application of engineering to a commonplace domestic duty, the present cost of electrical energy makes it almost as expensive, if not actually more so, than to accomplish the same object by the old-fashioned manual process of sweeping and dusting. The same remarks apply to practically all the later applications of electricity to household requirements. You can wash, cook, polish, dust, iron, and clean boots and knives with the aid of electricity and with practically no expenditure of manual energy, but it will cost you nearly as much as did the old-fashioned housemaid, who grew up with the family and learnt to run a house of her own by the time she married and left.

ELEKTRON.

SOME RECENT DEVELOPMENTS IN LARGE STEAM TURBINE PRACTICE.

(*Continued from page 222.*)

STARTING OF LARGE TURBINES.

One of the most important points in connection with the operation of large turbines of 20,000-kw. capacity and over is the necessity for extreme care in the starting and loading of units, especially when the machine has been idle for a period long enough to lower materially the temperature at which the various parts are normally operated. With the introduction of steam to a cold unit there is at once set up a difference in temperature between the various elements, which, unless a careful procedure is followed, may result in unequal expansions, affecting the shafts, blading, diaphragms, packing or casing joints. In some cases on record, sudden and unequal expansion has caused deformation which has resulted in permanent distortions to casings and bearings, materially affecting the subsequent operation of the machine.

A survey of the operating methods in use in a number of companies indicates that there is considerable variance in the practice which is followed in starting large turbines. The time required to heat up a cold unit to the point where full load can be carried will, naturally, vary with the type, size, and class of turbine. No hard and fast rule of procedure can be definitely laid down, except that in all cases no large unit can be safely loaded which has not been given sufficient time to allow all parts of the unit to reach evenly and gradually the individual normal operating temperatures corresponding to load conditions.

"Data secured from operating companies show that the procedure generally followed consists in establishing a partial vacuum of from 15 to 20 in. prior to starting up the unit, and maintaining this during the period of warming up.

"In warming up the turbine and bringing it to speed, the first operation of introducing steam should admit a sufficient volume to start the rotor turning immediately. Steam admission should then be so regulated that the unit will continue turning at a speed not exceeding 10 per cent. of the normal operating speed until the warming-up process is completed. Additional steam should then be admitted gradually to the turbine in order to bring it up to full speed.

"While the time taken for this operation varies among different operating companies, the safe minimum time allowed, based on best operating experience, is given as 20 min. for units of 20,000 kw. capacity, and 30 min. for units of 30,000 kw. capacity.

"In applying load to the unit, the rule observed for safe operation by a number of operating companies is to increase the load on the unit at a rate not exceeding 1,000 kw. per min. for units for the above size. While there is considerable variation from the procedure noted above, this is due in many cases to certain local requirements, or to special plant conditions which govern each particular case. It will be noted, therefore, that in following the above practice, the minimum time for heating up and loading large units will vary from 40 min. for a 20,000 kw. turbine to 60 min. for a 30,000 kw. unit, or a rate of 2 min. for each 1,000 kw. turbine capacity.

"These figures do not refer to machines which have not been idle long enough to cool off perceptibly, in which case shorter length of time can be taken, depending on the individual circumstances."

(*b*) *Vibration when starting.*—If vibration occurs during starting up, reduce the speed at once until vibration disappears, and keep running at the reduced speed for some time, after which the speed may again be increased.

(*c*) *Vibration when running.*—Keep the turbine and the generator in good running balance; if vibration increases for no apparent reason, shut the turbine down and examine the rotors.

(*d*) *Lubrication.*—Keep the lubricating system in perfect running condition; see that the stand-by oil pump is always in starting condition, if necessary, by keeping it running at low speed at all times.

(*e*) Test the emergency governor and valves before shutting down.

(*f*) Keep all drains in good working order.

While on the subject of large turbines reference might be made to the visit of Mr. S. L. Pearce, chairman of the Manchester Electricity Committee and City Electrical Engineer to America, to ascertain if any American practices could, with advantage, be adopted in the new Barton generating station.

The *Manchester Guardian* reports an interview in which Mr. Pearce said that, whilst he came across many features that could be embodied in the Barton scheme, he saw nothing to induce him fundamentally to alter the lay-out. The station, with its 150,000 kw. total capacity, compares with the Duquesne station at Pittsburg, U.S.A., of 360,000 kw. ultimate capacity supplied by six 60,000-kw. sets. Large American generating sets have not been a complete success, and there is a tendency to proceed more slowly and generate with sets of a more moderate capacity. The explanation given was inability to obtain proper materials during the war period. No faults in design are admitted, but Mr. Pearce is not prepared to accept that statement. He, however, states that the Americans are much keener on extracting the utmost power from their boiler-houses. There is much likelihood, Mr. Pearce thinks, that pulverised coal will become the boiler fuel of the future. Americans are awaiting the results of the trials in the Milwaukee stations; in Manchester they may wait, or investigate on their own at Stuart Street later on. "It is certainly a thing we shall have to consider."

One cause of trouble in large units has undoubtedly been due to the use of substitutes for the highest-grade material obviously necessary, for instance, a material known as "semi-steel" has been used in some instances for such important parts as the casing itself with disastrous results. Generally speaking, semi-steel is nothing more than a

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variety of cast iron and has not lived up to expectations, though it can be used with advantage for those purposes where cast iron is normally used. Genuine semi-steel is crucible melted in a neutral atmosphere, but the ordinary method of production is merely to add steel scrap with the pig iron charged into the cupola. A semi-steel of remarkably good mechanical properties is produced by the simultaneous melting and carburisation of steel scrap in the electric furnace, but the process is comparatively expensive. Under carefully controlled conditions, semi-steel can be manufactured having a tensile strength of 17 or 18 tons per sq. in.

It will be remembered that the alternator of one of the 15,000 kw. turbo-sets at the new Dalmarnock power station in Glasgow recently broke down, another alternator was substituted, and this also broke down. The cause in both cases was due to vibration. Both machines were of standard construction, heavily insulated and showed no faults when tested. The trouble manifested itself in the first machine by the windings taking fire. The second machine was carefully watched, and after operating on commercial load for about a week, sparks were seen issuing from the top of the stator frame. Examination showed that one of the insulated bolts passing axially through the core to hold the end-plates in position had broken down near the end-plate. The bolt was removed, and it was found that it had vibrated violently and the insulation had broken down near the centre of the core as well as near one end. The windings were found to be in perfect condition, but an inspection of other bolts which had not given trouble showed that vibration of a more or less serious nature had occurred on several of them.

A series of tests and investigation was at once undertaken, and it was found that for the particular length and diameter of bolt used a relatively slight tension was sufficient to bring the frequency of the bolts to such a value as to synchronise with the frequency of vibration of the whole set, corresponding to the speed of 1,500 revolutions per minute. A further and more careful inspection of the first machine which had broken down showed that the breakdown was due to a similar trouble, as it was found that one of the bolts had broken down to the core, and molten metal had come into contact with the insulation at one end of the machine, thus setting it on fire.

A third generator was practically ready for running at the time the first breakdown occurred, and it was decided to remove the steel core bolts and replace them with copper bolts of similar diameter which would carry heavier insulation. These bolts are stressed to such a low value as to leave their natural frequency very far below the running frequency of the machine. A considerable amount of work was required in order to replace the bolts, but this was done in an exceptionally short time, and before the end of the month the work had been completed and the machine was under load. Since this time it has carried peak loads up to 21,000 kw. The two machines which broke down are being rewound, and will shortly be in commission.

The use of core bolts has been the standard practice on the part of many companies in this country, America, and on the Continent. Machines have been in operation for fifteen years in which this construction has been used. This is the first case on record where trouble has resulted due to the use of the core bolts, and it is very remarkable that it should have occurred on two machines in such rapid succession, though the fact that they are duplicates and built by the same workmen may explain this. The trouble was due to the fact that a peculiar combination of conditions resulted in the bolt having a frequency equal to that of the machine, and vibration once having been set up, the insulation on the bolts was more or less rapidly disintegrated.

Worcester.—About £62,000 is estimated to be required for extensions during the next three years. Application to borrow the amount is to be made to the Electricity Commissioners.

RAWLINGS BROS.' SOCIAL.

PROGRESS OF THE FIRM DURING 35 YEARS.

On the evening of April 19, Rawlings Bros., Ltd., the well-known, old-established contractors of Gloucester Road, South Kensington, held their first annual social after the war at the Kensington Town Hall, where between 300 and 400 of the employees and their friends had an interesting and noteworthy time. During the evening Mr. W. R. Rawlings (joint managing director) gave some interesting facts concerning the Company, stating that he and his brother, John Joseph, started in business in Kensington 35 years ago as general engineers, adding immediately the electrical side. Thus they were practically the first to start electrical contracting in Kensington, where they dealt with the whole of the fittings for St. Jude's Church, which was the first church in the district to have an electrical installation. With the advent of the motor-car they started many garages in London (the largest of which was commandeered by the Government during the war and has since been sold), but a large business is now being carried on at Gloucester Road and Ashburn Mews, and at their many well-equipped garages.

In 1900 the business was turned into a limited company, additional premises taken over in Gloucester Road, and a decorative dept. which is still working with success was started. Two years ago Messrs. Hacking's premises in Gloucester Road were taken over and the head offices transferred there. Although these premises are insufficient to provide accommodation for all, it has added to the comfort of the staff generally. The firm to-day is progressing in every dept., and is in a strong financial position, having paid off all debentures and mortgages, thus leaving the assets in a free state.

Development of the Rawlplug, invented by Mr. J. J. Rawlings, has necessitated additional capital and a separate limited company has been formed. The Rawlplugs are manufactured at a well-equipped factory at Lewisham. To show the rate of progress of this invention it is interesting to note that the Rawlplug Co. now occupy and use the whole of the offices at Lenthall Place which were vacated two years ago by Rawlings Bros. for their present new offices at 95, Gloucester Road.

Among other interesting features Mr. Rawlings mentioned that there were 23 employees now with the Company who had been with them upwards of 20 years, some even over 30 years, and the directors desired to mark their appreciation by presenting to each a suitably inscribed gold compass pendant. It is evident that, surrounded by such a large body of long service men, the Company do not suffer from strikes, and as a further illustration of the employees' interest he mentioned they had invested on loan with the Company about £1,000, on which interest at the rate of 7½ per cent. per annum was paid, and it was hoped in the near future to be able to increase this to 10 per cent. The employees also had the Rawcester and Benevolent Funds, both of which were doing good and useful service.

It was announced in the course of the evening that Messrs. J. J. and W. R. Rawlings personally desired to commemorate the occasion by giving 700 fully-paid ordinary shares of £1 each in Rawlings Bros., Ltd., to the old employees:—£100 each to the three oldest

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employees and £100 each to four other employees, the latter being balloted for. The recipients of this generous gift were Messrs. F. Smith, W. Mendham, G. E. Tanfield, F. W. Merritt, F. Howard, A. Hanham, and C. J. Banister.

The full success of the evening was further ensured by a concert, which included songs by Miss Victoria Mulvey (soprano) and Miss Maidie Clifton (contralto), and humorous songs at the piano by Mr. Richard Arthur and Maskell Bros. (one of the latter being an employee of the Rawlplug Co.). Miss Gladys Ely, of Wimbledon, recited in her usual brilliant style and kept the audience in fits of laughter from start to finish. A great entertainment was afforded by Mr. Arthur J. Hill in his ventriloquial vagaries and his living marionettes, and from the reception given him it could be seen how well he satisfied his audience. The selections on the piano were very successfully rendered by Mr. E. Sargood, and the thanks of the audience were expressed to Messrs. Kingston Miller for the excellent refreshments which they had provided. Thanks were tendered to the young ladies (so daintily dressed) who saw that everyone had a programme, this being a real work of art produced by the departmental manager, Mr. C. J. Kelly. The collection for the programmes amounted to £9 4s. 6d., which goes to support the employees' Benevolent Fund.

TELEGRAPHY.

Being Solutions to the Questions set in the Final Examination in Telegraphy held by the City and Guilds of London Institute in April, 1920.

(*Concluded from page* 231.)

Q. 11.—As the result of low insulation on a line, duplex working is found to be impracticable, and simplex working, which is satisfactory, is resorted to. Give a clear explanation of the cause of the failure to work duplex.

A.—For good duplex working, it is essential that the resistance and capacity of the compensation circuits should be exact counterparts of the apparent resistance and capacity of the line circuit. This is necessary in order that the outgoing currents may not affect the home relay. The apparent resistance of the line circuit, however, depends not only on the conductor resistance of the wire, but also on its state of insulation. If the latter is very low the apparent resistance of the line is reduced, and more current will flow through the line circuit than through the compensation circuit at each station. To restore the balance it is therefore necessary to reduce the resistance in the compensation circuits. The state of insulation of a line also affects the capacity balance to a certain extent, because the charge on the line discharges much more readily in wet weather than in dry, so that in the former case it is necessary to reduce the capacity in the compensation circuits to prevent disturbances on the relays and consequently unsatisfactory duplex working. If after these adjustments of the compensation circuits have been made duplex working is found to be impracticable, the trouble is due to the reduction in strength of the incoming current owing to loss by leakage along the line. Even in these circumstances duplex working may sometimes be restored by increasing the battery power, but where this is not practicable simplex working is resorted to. The reason why simplex working is satisfactory under such conditions is that the reduced incoming current passes through both coils of the relay joined in series, whilst in duplex working it passes through one coil only. The pull on the tongue of the relay in the latter case would be therefore only one-half of that in simplex working, so that the sensitivity of the relay is reduced by 50 per cent.

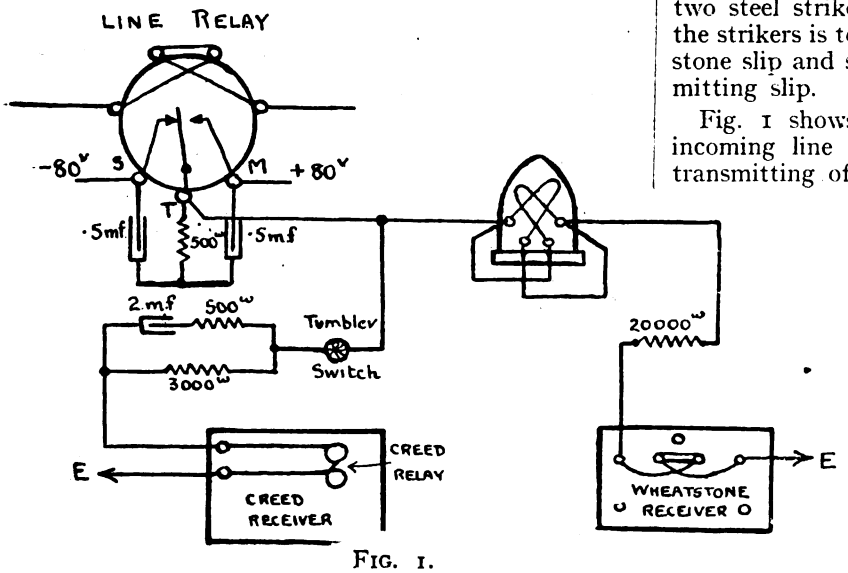


FIG. 1.

Q. 12.—What are the functions of the relay used on the Creed receiving perforator? Give a diagram showing how this relay is operated from the line currents.

A.—The relay on the Creed receiving perforator is somewhat similar in construction to the Post Office standard type, except that the axle carries a light arm instead of the tongue. The movements of this arm result in the opening and closing of air valves, which cause a piston to move, under pneumatic power, in accordance with the movements of the arm. These movements are next communicated to a larger piston, which is made to act upon two bell-crank levers, having two steel strikers connected to them. The action of the strikers is to force steel punches through the Wheatstone slip and so to reproduce a facsimile of the transmitting slip.

Fig. 1 shows the connections of this relay. The incoming line currents from the distant Wheatstone transmitting office pass through the line relay at the Creed worked end, and cause the relay tongue to move between its contacts, which are connected to positive and negative voltages of 80. The currents picked up by the tongue are then transmitted through the Creed relay, and a Wheatstone receiver connected in parallel to the tongue operating both. The 5-m.f. condensers and 500-ohm resistance connected to the contacts and tongue of the line relay are for the purpose of quenching the sparks which would otherwise result when the tongue moved between its

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contacts. The effects of the inductance in the Creed receiver relay are neutralised by means of the condenser and resistance system to the left of the tumbler switch. An adjustable 20,000-ohm leak resistance is placed in series with the Wheatstone receiver for the purpose of providing the proper working current through the instrument.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 115.

Can any reader give me some information concerning the testing of steam turbines and generators?—"VACUUM."

QUESTION NO. 116.

I would appreciate full constructional details of a resistance which is to reduce 100 volts to 80 volts when a current of 5 amperes is passing for an indefinite period. How shall I wind the wire? Will mica or enamelled insulated steel tubes be satisfactory?; and what size and kind of wire is most suitable if the temperature is not to exceed 300 deg. F.? The resistance is to be enclosed in a flame-proof box, and the use of oil, for cooling, is prohibited.—"B."

(Replies to Questions Nos. 115 and 116 must be received not later than April 30, 1921.)

Answers to Questions.

REPLIES TO QUESTION NO. 114.

The first prize (10s.) has been awarded to Mr. S. J. Berryman, Gustavus Road, Camborne, for the following reply:—

The advantage of the shunt motor over the series motor is its speed is constant on all loads, whereas the speed of the series motor varies, with an increase of load the motor speed decreases, and with a decrease of load the motor speed increases, this being due to the variation of the field current. Should the load of a series motor be thrown off suddenly it is liable to race, this being at least one reason why the shunt motor is to be preferred to the series motor for lift work.

Winding Gear.—In some makes of winding gear there are two drums, the one taking the cage rope and the other the balance rope, one winding in while the other pays out. In other makes the balance weight and cage are secured to opposite ends of the same rope, which pass over the winding drum in V grooves which have sufficient grip to drive the ropes. Both systems appear to be very satisfactory and both are claimed by their respective makers to be the best. As it is usually necessary that lift gears should work silently, worm gearing is used to transmit the power from the motor to the winding drum. Three principal methods are in use by which a person in the cage can start, stop or reverse the winding gear.

Pull-rope System.—The first and simplest arrangement consists of an endless rope, one part of which extends from top to bottom of the lift well, and passes through the cage, the other part being led round guide pulleys in any position required. This rope is attached in some convenient place to the handle of the winding gear controller switch so that the person in the cage can, by pulling the rope, start the cage in either direction, or stop it at any required point.

Car-switch System.—In the second arrangement, known as the car-switch system, a flexible cable is led from some convenient point in the lift well to the cage, sufficient slack being left to allow free movement. The cable makes connection between a small two-way switch in the cage and two magnets or solenoids or other arrangements, which cause the controller to start the gear in one direction or the other, according as the two-way switch is turned to the right or left, the gear stopping when it is placed in the middle position.

Push-button System.—In the third arrangement, known as the push-button system, the gear may be operated either by a person in the cage or at any of the floors. A push-button is placed at every floor, and a number of push-buttons equal to the number of floors are placed in the cage. These push-buttons are connected by flexible and other leads to suitable magnetic arrangements on the lift controller.

Controllers.—As it is essential that electric motors should have a resistance in their circuits when starting, and that this resistance should be gradually cut out as they speed up, and as it is impossible for gradual cutting out of the resistance to be performed by the person in the cage, some automatic means must be provided for doing it. A lift controller contains three essential parts, (1) a main switch to open and close the circuit, (2) a reversing switch to control the direction of running of the winding gear motor, (3) a switch and resistance with a suitable number of contacts. On either of the foregoing systems, the switches 1 and 2 are worked from the cage, while 3 has to be worked automatically. The following describes some of the methods which are adopted: (1) The switch arm is driven round by a falling weight, the speed being controlled by a dashpot. This arrangement is only suitable for the pull-rope system. Pulling the rope to start frees the weight, and pulling it to stop raises the weight and switches in the resistance ready for a fresh start. (2) The switch arm is weighted and pulled up by a solenoid switched on by 1 or 2, the speed being retarded by a dashpot. On breaking the circuit the weighted switch arm falls, so switching in the resistance. (3) The switch arm is driven by a speed-reducing gear from the motor shaft, and is weighted so as to fall back when the circuit is broken. (4) The switch arm is driven by a small auxiliary motor, and falls back either by a weight or by a spring when the circuit is broken. (5) The separate sections of resistance are connected to contacts having short-circuiting switches attached to the plungers of a series of solenoids wound to operate with different pressures, and having their windings connected to the motor terminals. When 1 and 2 are closed the motor starts, and as its speed increases the pressure across its terminals rises. When it has risen to a certain value, the first solenoid acts, short-circuiting the first section of resistance, so causing a further increase of motor speed and pressure, which causes the second solenoid to operate, and so on until all the resistance is short-circuited. On breaking the circuit the solenoids all drop their switches, so putting in the full resistance again, ready for the next start.

In another arrangement of solenoid controller, connection to the solenoid is made and broken by a switch moving over a series of contacts. This switch is pulled on by a solenoid, and, having a weighted arm, it drops off automatically when the solenoid is de-energised. The speed at which the switch is pulled on is regulated by a dashpot.

Safety Appliances.—In the motor circuit the usual fuses or circuit-breakers are provided, which will act if the cage is overloaded. In the pull-rope system, buttons are attached to the rope at the top and bottom of the lift well, the positions of these buttons being such that if the cage overruns its proper position it catches one of the buttons, so operat-

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ing the controller and stopping the motor. In the other systems the same effect is obtained by means of electric contacts, which are operated by the cage if it overruns its proper position. Safety grips are provided on the cage, which, if the rope breaks, will grip the upright guides and prevent the cage from falling.—S. J. Berryman.

The Second Prize Winner's reply will be published in our next issue.

Various Items.

Social.—The concluding social evening of the Ediswan (Bristol) Staff was held at the company's showrooms on April 6, when a somewhat lengthy but well-varied programme was given by members of the Staff and their friends, and was much appreciated by the audience.

Good News.—Members of the Institution of Electrical Engineers and others will be glad to hear that the work of redecorating the Institution building is being rapidly proceeded with, and that there is every prospect that the Institution will be reinstated, at least on the ground floor, by the middl of May next.

Chester.—An important development of electricity supply for Chester and the Deeside district was discussed at a special meeting of the Hawarden R.C. It was stated that the War Office had submitted an agreement for the supply of electrical energy from H.M. Factory, Queen's Ferry, in bulk. The agreement is for two years, subject to 12 months' notice on either side; all expenditure necessary to make the supply available to be borne by the joint committee; £4 10s. to be paid per kw. for current up to 3,000, and £4 per kw. afterwards; and the joint committee to pay the costs of generation—i.e., wages, fuel, oil, waste, and water, maintenance and repairs, plus 7½ per cent. on these. It was stated that the Chester Corporation were prepared to carry the scheme through, failing the co-operation of the Hawarden Council, which was invited, and failing co-operation and membership of a joint committee with financial responsibility on a basis to be agreed, Chester will supply electricity in bulk in the Hawarden Council's area. There is a possibility of Wrexham joining in the scheme, which will be absorbed in the larger scheme when the joint electricity authority under the new Act is set up.

Prussian Jackboot Tyranny.—On Sat., the 16th inst., at the North London Police Court, a summons was granted against the Hackney Borough Council for failing to supply electric power to certain premises contrary to the provisions of the Hackney Electric Lighting Order, 1893. The solicitor explained that his client had made formal application for a supply of electricity, which the Council were bound to give, and had employed a master man to do the wiring inside the premises. When the work was completed he gave notice to the Borough Council, and requested that his premises should be connected with the electric main. While the work inside the premises was in progress the electrician received a visit from a person representing himself as a shop steward from the Council's electricity department, who requested to see his "ticket." "What ticket?" asked the electrician. "Your union ticket," was the reply. To this the electrician answered, "I am a master man and do the work myself. I employ no labour." The shop steward informed him that as he did not belong to the union the Council's men would refuse to connect the premises, and this decision was subsequently confirmed by the borough electrical engineer. Under Section 26 of the Order the Council became liable to a penalty of 40s. a day for refusing to connect the premises. Of course, this action of the trade union is sheer despotism and means that if a properly qualified electrician does not belong to their union he is not to be allowed to work and live. We have yet to learn that a trade union decision is to be allowed to over-ride the actual law of the land, that a man has a right to live and work.

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Personal.—The professional practice of the late H. B. Ransom, Esq., M.Inst.C.E., 3, Victoria Street, S.W.1, has been transferred to Messrs. Dolby & Williamson, Consulting Engineers, 8, Princes Street, Westminster, S.W.1, to whom all correspondence should be adressed.

Barnsley.—Application is to be made to borrow £22,000, for mains extensions to the housing scheme areas. The output of electricity has increased by 40 per cent. during the past year. The T.C. has approved the Bradford draft scheme for distribution through areas under the recent Act.

Electric Light for Pontardulais.—Relative to negotiations of the Llandeilo-Talybont U.D.C., Swansea Corpn., and the Electricity Commissioners which have now been brought to a close, it is hoped that the work necessary for lighting Pontardulais with electricity will be commenced in a few days. The maximum price set forth in the order issued is 10d. per unit. For the winter quarters ending March 31 and December 31 the minimum will be 15 units for 12s. 6d., and for the other two quarters 10 units for 8s. 4d.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 29th inst., at 8 p.m. Discursive Lecturette: "Rambling Remarks on Expert Evidence," by W. A. Tookey, M.I.Mech.E. (Member); also on Friday, May 6, at 8 p.m. Lecturette: "Fire Resistance of Aggregates for Reinforced Concrete, by D. W. Wood (Associate); and on Friday, May 13, at 8 p.m. Lecturette: "Scientific Developments in Gas Measuring Instruments," by H. G. Brown (Associate Member) (Durham Bursar's Paper). All at Caxton Hall.

Benevolence.—In connection with the offer of Mr. E. M. Hughman, of Bombay, to give a donation of £250 to the Benevolent Fund of the Inst.E.E., on condition that 19 similar donations are received by June 30, the Committee charged with the raising of the fund have obtained Mr. Hughman's consent to the sums of £250 not being contributed solely by single donors, but by group subscriptions. The Territorial Centres of the Institution are taking steps to organise such group collections, and the Secretary of the Inst.E.E. (1, Albemarle Street, W.1), will reply to any inquiries on this subject.

Dundee.—The T.C. is erecting 80 three-flatted houses and 420 cottage dwellings. At Balgay, near the Blackness car terminus, 160 of the latter are to be built, mostly containing living-room, parlour, three bedrooms, with a good scullery, and other accommodation, while it is also proposed to have the sculleries so designed that they will be large enough to accommodate electrically-driven washing machines and wringers. A specimen electrical house is in course of erection and was recently inspected by the Councillors. The whole of this district is intended to become an electric suburb.

Service Notes.—Recruiting for the electrical branches of both Services is doing very well in Great Britain. Few recruits, are coming from Ireland. Mr. E. E. Benham, first assistant electrical engineer at Devonport Dockyard, has been appointed to Gibraltar Dockyard in succession to Mr. P. A. Yapp, who has been invalided home. Mr. Benham, who has been first assistant electrical engineer at Devonport since May, 1918 (acting electrical engineer), will be replaced at Devonport by Mr. Yapp as soon as the latter is fit for duty again. In future, the head of the electrical section of the Admiralty Dockyard department will be known as "Assistant Director of Dockyards (E.E.)."

Extraordinary Accident.—As a boy named Evan William Jones (16), of Hill Street, Rhumney, was playing near the river, parallel with which runs the Powell Duffryn Colliery Co.'s 10,000 volt cables, he told his playmates he was going to have a slide. Immediately afterwards he climbed up the woodwork which supports the cables, and by some means touched the wires and immediately became a mass of flames. He fell to the ground a few moments later. Police-Sergt. Clinch and Dr. Dowd, of Brithdir, were soon on the scene, and they found the lad had sustained frightful injuries and that his left leg and fingers of his hand had been completely burnt away. He was conveyed to Aberbargoed Hospital, but died soon after admission.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
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MAY 6, 1921.

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THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

By Sir William Noble, M.I.E.E.

(*Continued from page* 224.)

For through-switching purposes between the same points, circuits having a transmission equivalent between main test-boards of 12 standard miles (i.e., $\beta l = 1.28$) are necessary, and on this basis a full-sized cable will carry 19 quads of conductors, giving a maximum of 57 circuits including phantoms.

In order to obtain the necessary quality of transmission for direct service between centres 400 miles apart, e.g., London and Glasgow, it would be necessary to use conductors of much heavier gauge, and a full sized cable for such a service would carry no more than 12 quads, giving a maximum of 36 circuits including phantoms, but it is not at all certain that such a cable would be a practical manufacturing proposition.

It appeared therefore that it would be necessary to increase considerably the capacity of underground duct routes in order to cope with the expansion of traffic which would follow on the extension of the underground system.

At this juncture, however, the solution of one of the fundamental problems of long-distance underground telephony, namely, the construction of an effective telephone relay or repeater, seemed possible.

The conception of a repeater which could be inserted in a telephone circuit and fulfil the same functions as a repeater in a telegraph circuit is almost as old as the telephone itself. From the earliest days of the telephone art many investigators had worked patiently on this problem, and the records of the British Post Office contain reports of long and patient trials of innumerable telephone repeater devices submitted by inventors from time to time. Prior to the introduction of the three-electrode thermionic valve, these devices were invariably of the microphonic type, in which a sensitive microphone was attached usually to the reed or diaphragm of a telephone receiver. Seeing that the energy available in a telephone circuit for operating a repeater is of the order of a few microwatts, it seems almost incredible that the inventors of microphonic repeaters should have been able to design anything that would function as an amplifier of the minute currents of speech frequency, and the fact that several such devices have been actually used in commercial circuits with moderate success is sufficient testimony to the patience and ingenuity of the early workers. In the light of our present knowledge and the possession of an almost perfect amplifier, it can be seen why the early attempts were not successful.

* Paper read recently before the Inst.E.E.

Our present knowledge of the laws of the electrical transmission of speech over wires is due very largely to advances in physical science which in themselves are not specifically associated with telephony and which have preceded the development of the thermionic amplifier.

The introduction of the three-electrode thermionic tube completely changed the aspect of the telephone repeater problem. The early experiments of the Post Office, commencing in 1913, were conducted with "soft" valves which, while not wholly suitable for the requirements of a commercial repeater, enabled engineers to make considerable headway in the design of repeater circuits, and emphasised the necessity for more complete measurements of the impedance characteristics of telephone lines over the whole range of speech frequencies.

The "soft" valve has now been superseded by the "hard" valve for all telephone repeater work. The ideal thermionic valve for telephone repeater service should fulfil the following conditions:—

(*a*) Its general design should be such that it can be manufactured in large quantities with uniform electrical characteristics.

(*b*) Its electrical characteristics should remain constant throughout its working life.

(*c*) Small variations in filament current due to the normal voltage-drop of the filament battery during discharge should cause no appreciable change in the amplifying power of the valve.

(*d*) Its amplifying factor, in association with its input and output transformers, should be practically constant over the range of speech frequencies, and over the required range of input voltage amplitude.

(*e*) The electrodes and their supports should be sufficiently rigid to ensure that no vibration from external sources affects the performance of the valve.

(*f*) Power consumption in the filament should be as small as possible.

(*g*) Long operating life.

The thermionic valve with its associated input and output transformers has only a unilateral action as an amplifier. For use in the ordinary two-wire telephone circuit it must be duplexed in order to transmit and amplify speech currents in both directions through the circuit. The duplexing is effected on the principle of the duplex telegraph relay, by the use of differential winding on the line side of the output transformer (see Fig. 2).

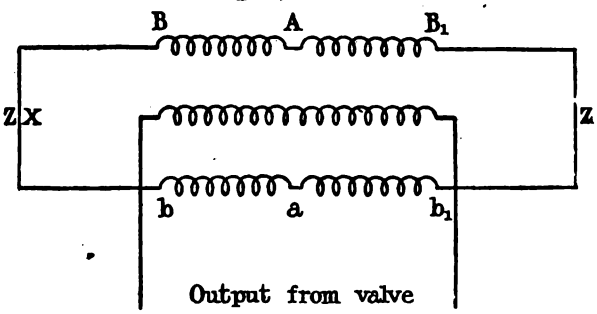


FIG. 3.—LINE CIRCUIT OF TELEPHONE REPEATER CLOSED THROUGH TWO EQUAL IMPEDANCES.

Speech currents from the up or down lines pass around the line windings P, P of the output transformer in series. The primary of the input transformer being joined across the middle points of the windings is a shunt on the line circuit, and a portion of the line current passes through it and is amplified by the valve. The amplified outgoing currents are transmitted to the up and down sides of the line in series, and if the two sides are electrically equal the potentials at the middle points of the windings P, P are equal, and no part of the amplified current is fed back into the input circuit.

If the repeater circuit be represented by Fig. 3 it will

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be seen that in a properly constructed transformer with an equal number of turns in all the windings AB, AB_1, ab, ab_1, the E.M.F. generated in all the windings by an alternating current flowing through the secondary will be equal. The impedances of the windings will also be equal. If the circuit be completed by the two equal impedances Z, the circuit may be presented in straight-line form as in Fig. 4, the point X being taken as the starting point.

In practice, the use of the simple differential repeater circuit shown in Fig. 2 is limited to those cases where the repeater can be inserted at the electrical centre of a homogeneous and stable line circuit. This condition is obtainable generally only in well-constructed cables. In this country it is seldom obtainable on aerial lines owing to the variations caused by our climatic conditions.

(To be continued.)

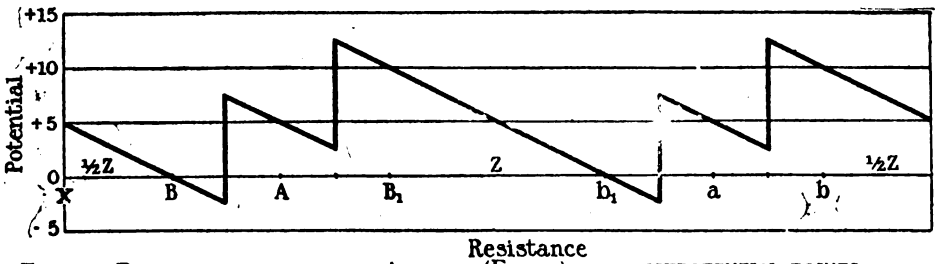


FIG. 4.—DIAGRAM SHOWING THAT A AND a (FIG. 3) ARE EQUIPOTENTIAL POINTS.

For the sake of simplicity the E.M.F. of each winding is assumed to be concentrated at the centre of the winding. The impedances have been represented to scale. Obviously the total voltage drop in the circuit must be equal to the total E.M.F. in the circuit. A drop of 5 volts has been assumed between the point X and the point B. There will be a corresponding drop between any two points having the same resistances between them. The total on the scale chosen will therefore be 40, and each winding must therefore produce an E.M.F. of 10 volts. It will be clear from an inspection of the voltage curve that, under the conditions given, the potential of A will be equal to that of a. This will hold good in any case if the circuit is symmetrical about these points so far as E.M.F.s and impedances are concerned.

An alternative arrangement of the transformer windings is shown in Fig. 5. It will be noticed that if lines of dissimilar impedance be connected to the repeater shown in Fig. 2, the potentials at the mid-points of the line transformer will be unequal. Consequently an out-of-balance current will flow through the input circuit, and if this current reaches a certain value, the amplifier will generate oscillations at a frequency determined by the electrical constants of the circuit. The resulting noise may be sufficient to make speech impossible between the terminals of the circuit, and in any case will reduce the transmission improvement of the repeater.

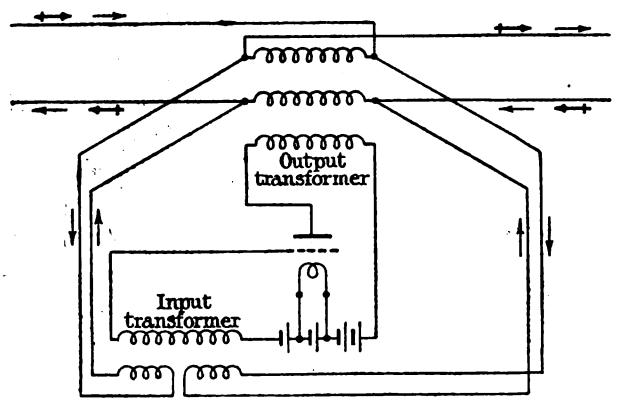


FIG. 5.—TWO-WAY TELEPHONE REPEATER WITH SINGLE AMPLIFIER (ALTERNATIVE ARRANGEMENT TO FIG. 2).

In the early days of microphone amplifiers this unbalance difficulty did not cause serious trouble, as the amplifiers were relatively insensitive; but since the introduction of the thermionic valve amplifier the unbalance difficulty has become more important. In fact it may be said to be one of the chief difficulties in modern balanced repeaters.

SHIP LIGHTING IN RELATION TO COMFORT, SAFETY AND EFFICIENCY.

The subject of ship-lighting was discussed at the last meeting of the Illuminating Engineering Society on April 26. Mr. Chas. Wordingham, C.B.E., presiding. Representatives of the Admiralty and the Mercantile Marine Service Association were present and joined in the discussion.

Mr. W. J. Jones, in reading the introductory paper, pointed out that in the case of large vessels the amount of energy required for lighting formed only 1-2 per cent. of the total energy developed. There seemed to be no need for parsimony, therefore, in such cases. A distinction was drawn between conditions on a large liner with its own electric supply available for lighting and cargo vesesels where the supply may be more limited, and again in sailing vessels where no supply may be available. Electric lighting has manifest advantages for ship-lighting in view of its being unaffected by gales of wind and comparatively unaffected by severe weather conditions. It is, however, vital in passenger vessels to ensure that there are spare generators to be put in use in the event of a breakdown, and also an emergency plant, sometimes with an oil-engine, placed well above the water-line; accumulators are sometimes installed to serve the same purpose. Any electromagnetic gear must also be stowed well away from the compass bowl so that the needle may not be affected by passing currents.

Mr. Jones illustrated modern methods by referring to the *Majestic*, launched 30 years ago, which utilised only 1,200 16 c.p. carbon filament lamps, as compared with the 12,000 or more metal filament lamps used by a modern liner. Fittings must, of course, be of a rigid character, unaffected by the motion of the ship, and their design is also considerably influenced by considerations of limited overhead space.

Mr. Jones quoted the Board of Trade Regulations where it is specified that "foreign and home trade vessels are to be properly lighted and ventilated day and night," but remarked that there seemed to be in existence little information in the form of standard schedules of amount of illumination, such as are usual in dealing with installations on land. One interesting special device exhibited at the meeting was the signalling apparatus which served to show when the Board of Trade lights are burning satisfactorily. Special methods of lighting charts by concealed lamps are also available, while searchlights, even on merchant vessels, may serve useful functions, for example in assisting the rescue of persons floating in the sea in the event of a shipwreck; luminous signals, including those serving as signals of distress, were also briefly mentioned.

In dealing with the lighting of various classes of vessels Mr. Jones gave the results of measurements of illumination in typical cases, and also quoted a table given by Lieut. McDowell for illumination in the United States Navy. The engine-room, boiler-room, hold and tunnels demand special

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lighting methods, and importance is attached to the painting of exposed surfaces in white so as to facilitate diffusion of light. The lowering of boats in emergencies is frequently a matter of difficulty, and lights are sometimes placed between the davits, also serving to assist loading or unloading. It is also usual to have lights suspended over the cargo-hatches to facilitate taking in and storage of cargo. As regards the nature of lamps, ability to withstand shock and vibration is naturally an important factor, and those of the helical traction type have proved very satisfactory. The author emphasised the desirability of a standard voltage on board ships, both in the Navy and the Mercantile Marine; the present variations in this respect add considerably to the expense of manufacture and make it more difficult to produce lamps of uniform quality in bulk.

In the subsequent discussion attention was drawn to the need for a schedule of illumination for various operations on board ship, and it was remarked that some of the values recorded by the author, notably only 0.3 ft. candles in the stewards' bathrooms, and a series in different rooms all below 1 ft. candle, seemed unduly low; the values given for practice in the U.S.A. Navy were considerably higher. Several officers in the Mercantile Marine joined in the discussion, alluding to the methods of concealed chart-room lighting mentioned by Mr. P. J. Waldram, and confirming the value of a signalling device to show when the B.O.T. lights were in order. Some discussion turned on the question whether it was advisable to provide general deck-lighting on vessels, it being contended by shipmasters that any exposure of lamps would dazzle the eyes in view of the surrounding dense darkness; it was thought possible, however, by some that moderate diffused lighting by completely concealed sources might prove useful. In conclusion it was suggested that the Illuminating Engineering Society should form a joint committee to prepare general recommendations and schedules of ship-lighting.

ELEMENTARY DETERMINANTS
WITH SPECIAL REFERENCE TO KIRCHHOFF'S LAWS.

BY H. P. FEW.
Silver Medallist in Telegraphy, etc.

NINTH ARTICLE.

NOTE.—The aim of these articles is to bring out prominently the advantages of employing Determinants, in conjunction with Kirchhoff's Laws, for finding current values in complicated networks of conductors. The previous articles appeared in our issues of June 25, August 6 and 27, September 17, October 22, December 3, 1920, February 25 and March 25, 1921, and gave an account, *inter alia*, of Kirchhoff's Laws and corollaries, Maxwell's cyclic equations, general methods of evaluating determinants, application of determinants to finding current values in simple networks, including the Wheatstone bridge and the Thomson double bridge. This article deals with the bridge duplex system of telegraphy.

In this article we apply the methods of determinants to finding the value of the current in the receiving branches of the bridge duplex system of telegraphy. This system of telegraphy is important as it is largely used for working submarine cables.

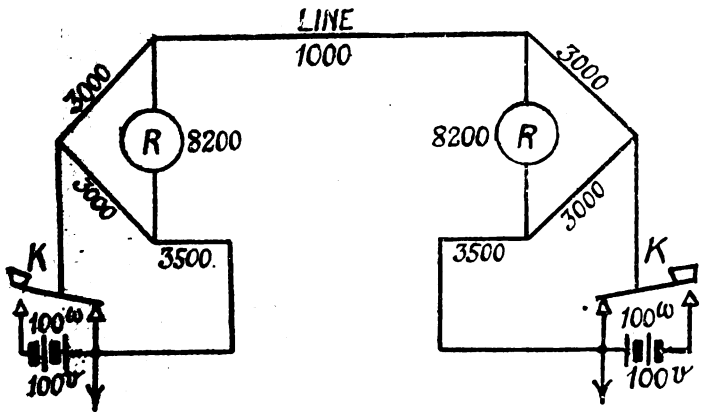


FIG. 20.

Fig. 20 shows the skeleton connections of the system. *KK* represent the signalling keys, and *RR* indicate the receiving instruments. The figures shown against the various branches represent their respective resistances, which are typical of several of the submarine circuits working between Great Britain and Ireland. The connections may be re-drawn as shown in Fig. 21.

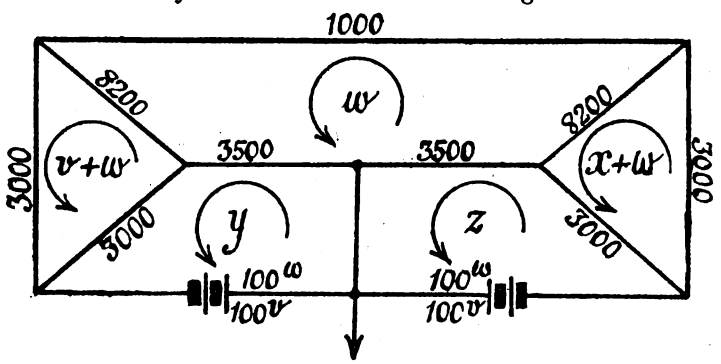


FIG. 21.

Our object is to determine the current value in the receiver branches when both keys are depressed—i.e., in the branches of 8,200 ohms resistance. Since the circuit is symmetrical, it is obvious that when both keys are depressed together the value of the current in both receiver branches should be the same. Suppose imaginary currents $v+w$, $x+w$, w, y and z to flow round the meshes as shown, then forming our equations according to Maxwell's rule, we have—

$$\begin{aligned}
-3000(v+w) - 3500w + 6600y &= 100\\
-3500w - 3000(x+w) + 6600z &= -100\\
14200(v+w) - 8200w - 3000y &= 0\\
-8200w + 14200(x+w) - 3000z &= 0\\
-8200(v+w) + 24400w - 8200(x+w) - 3500y - 3500z &= 0
\end{aligned}$$

Collecting like quantities, we get—

$$\begin{aligned}
-3000v - 6500w + 6600y &= 100\\
-6500w - 3000x + 6600z &= -100\\
14200v + 6000w - 3000y &= 0\\
6000w + 14200x - 3000z &= 0\\
-8200v + 8000w - 8200x - 3500y - 3500z &= 0
\end{aligned}$$

Writing down the determinant for v, we have—

$$v = \frac{\begin{vmatrix} 1 & -65 & 0 & 66 & 0\\ -1 & -65 & -30 & 0 & 66\\ 0 & 60 & 0 & -30 & 0\\ 0 & 60 & 142 & 0 & -30\\ 0 & 80 & -82 & -35 & -35 \end{vmatrix}}{\Delta}$$

where Δ is a determinant representing the denominator. Adding the top row to the second row to form a new second row, we get—

$$v = \frac{\begin{vmatrix} 1 & -65 & 0 & 66 & 0\\ 0 & -130 & -30 & 66 & 66\\ 0 & 60 & 0 & -30 & 0\\ 0 & 60 & 142 & 0 & -30\\ 0 & 80 & -82 & -35 & -35 \end{vmatrix}}{\Delta}$$

which reduces to—

$$v = \frac{\begin{vmatrix} -130 & 30 & 66 & 66\\ 60 & 0 & -30 & 0\\ 60 & 142 & 0 & -30\\ 80 & -82 & -35 & -35 \end{vmatrix}}{\Delta}$$

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Subtracting the third column from the fourth column to form a new fourth column, we get—

$$v = \frac{\begin{vmatrix} -130 & -30 & 66 & 0 \\ 60 & 0 & -30 & 30 \\ 60 & 142 & 0 & -30 \\ 80 & -82 & -35 & 0 \end{vmatrix}}{\Delta}$$

and adding the second row to the third row to form a new third row—

$$v = \frac{\begin{vmatrix} -130 & -30 & 66 & 0 \\ 60 & 0 & -30 & 30 \\ 120 & 142 & -30 & 0 \\ 80 & -82 & -35 & 0 \end{vmatrix}}{\Delta}$$

which reduces to—

$$v = 10 \times 30 \frac{\begin{vmatrix} -13 & -30 & 66 \\ 12 & 142 & -30 \\ 8 & -82 & -35 \end{vmatrix}}{\Delta}$$

Reducing this to determinants of the second order—

$$v = 300 \frac{-13\begin{vmatrix} 142 & -30 \\ -82 & -35 \end{vmatrix} - 12\begin{vmatrix} -30 & 66 \\ -82 & -35 \end{vmatrix} + 8\begin{vmatrix} -30 & 66 \\ 142 & -30 \end{vmatrix}}{\Delta}$$

and multiplying out—

$$v = \frac{300\left[13\{(142 \times -35) - (30 \times 82)\} - 12\{(30 \times 35) + (66 \times 82)\} + 8\{(30 \times 30 - (66 \times 142)\}\right]}{\Delta}$$

which gives—

$$v = \frac{-14619000}{\Delta}$$

The determinant for the denominator is—

$$\Delta = \begin{vmatrix} -30 & -65 & 0 & 66 & 0 \\ 0 & -65 & -30 & 0 & 66 \\ 142 & 60 & 0 & -30 & 0 \\ 0 & 60 & 142 & 0 & -30 \\ -82 & 80 & -82 & -35 & -35 \end{vmatrix}$$

and this reduces to three determinants of the fourth order, i.e. :

$$\Delta = -30\begin{vmatrix} -65 & -30 & 0 & 66 \\ 60 & 0 & -30 & 0 \\ 60 & 142 & 0 & -30 \\ 80 & -82 & -35 & -35 \end{vmatrix} + 142\begin{vmatrix} -65 & 0 & 66 & 0 \\ -65 & -30 & 0 & 66 \\ 60 & 142 & 0 & -30 \\ 80 & -82 & -35 & -35 \end{vmatrix} - 82\begin{vmatrix} -65 & 0 & 66 & 0 \\ -65 & -30 & 0 & 66 \\ 60 & 0 & -30 & 0 \\ 60 & 142 & 0 & -30 \end{vmatrix}$$

The value of these three determinants will be found to be -9459000, -2722591560, and -1396355040 respectively; so that

$$\Delta = -4128405600$$

$$\therefore v = \frac{14619000}{4128405600} \text{ amperes}$$

$$= 3{\cdot}5417 \text{ milliamperes,}$$

which is the value of the current flowing in each receiver circuit.

This result might have been arrived at more readily, as follows : Since the connections at both stations are the same, and since similar poles of the batteries are to line, no current flows in the line, which may therefore be regarded as disconnected. The circuit connections at either station then reduce to the two-mesh circuit shown in Fig. 22.

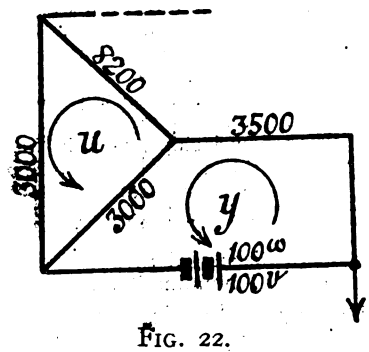


FIG. 22.

Forming our equations according to Maxwell's rule, we have—

$$14200u - 3000y = 0$$
$$-3000u + 6600y = 100.$$

Forming the determinant for u,

$$u = \frac{\begin{vmatrix} 0 & -30 \\ 1 & 66 \end{vmatrix}}{\begin{vmatrix} 142 & -30 \\ -30 & 66 \end{vmatrix}}$$

$$= \frac{30}{8472} \text{ amperes}$$

$$= 3{\cdot}5417 \text{ milliamperes.}$$

The same result is obtained by considering the receiver branch together with one of the arms as in parallel with the remaining arm, thus the current

$$C = \frac{100000}{3600 + \frac{11200 \times 3000}{14200}}$$

$$= 16{\cdot}76 \text{ milliamperes.}$$

Of this current

$$16{\cdot}76 \times \frac{3000}{14200} = 3{\cdot}54 \text{ milliamperes}$$

pass through the receiver.

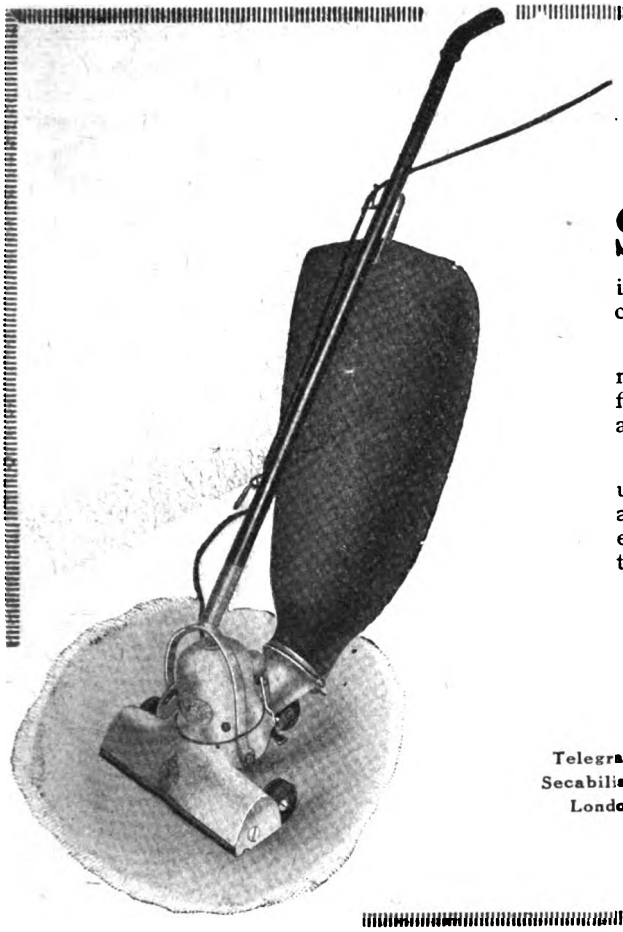
The above described method of working bridge duplex is known as the opposition method. If one of the batteries is reversed we have the combination method, so called because the batteries assist one another when both keys are depressed at the same time. It is left to the reader to calculate the current in either of the receiver branches when the batteries are in combination, assuming the same resistance values. In this case, the value of the current in either of the receiver branches will be found to be 26.8 milliamperes.

(To be continued.)

Gift.—The Prince of Wales has presented his autographed photograph to the Great Northern Hospital, of which he is President.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 6th inst., at 8 p.m. Lecturette, "Fire Resistance of Aggregates for Reinforced Concrete," by D. W. Wood. Also on Friday, 13th inst., at 8 p.m. Lecturette, "Scientific Developments in Gas Measuring Instruments," by H. G. Brown. (Slides.) And on Friday, 20th inst., at 8 p.m. Lecturette, "Liquid Fuels," by A. Arnold. All at Caxton Hall.

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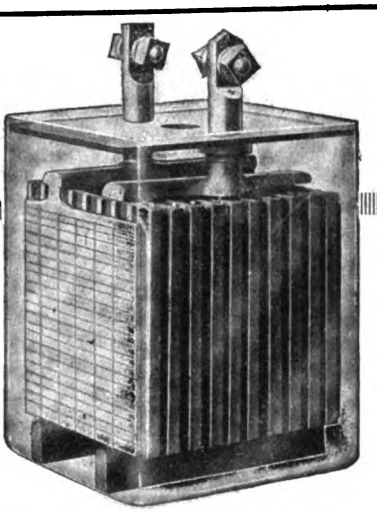
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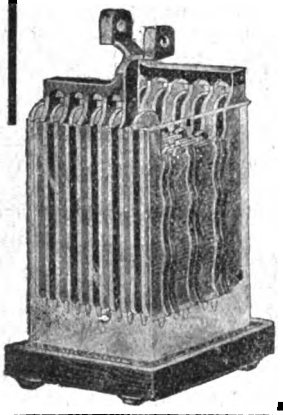
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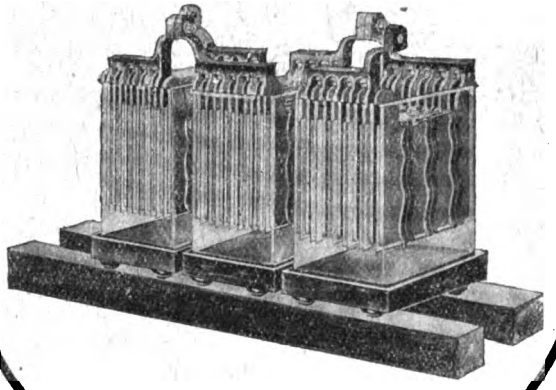
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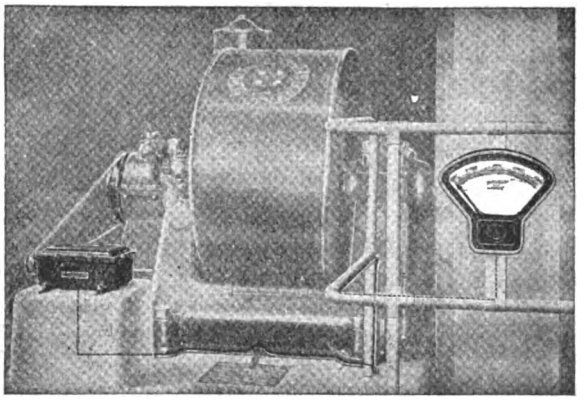


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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Childish

Really some trades union activities would lead one to believe that the industrial community was approaching its second childhood. In a recent case at Hackney a would-be consumer of electricity summoned the Hackney Borough Council for failure to supply electricity to his premises, which were ready wired and only waiting to be connected to the mains. It seems that the applicant's premises were wired by a working master electrician, who employed no additional labour, and was, in consequence, neither an employer nor an employee. In view of his trade status he did not belong to the E.T.U. nor was he a member of the Masters' Federation. As a natural consequence, the wiring was not carried out by trade union labour, a very criminal act in the eyes of certain extremists.

As a consequence of this, when in due course application was made for connection to the supply mains, the Council's workmen refused to carry out the work, and in consequence the applicant was deprived of his supply and brought the action above referred to. Here we have an absurd deadlock with absolutely no justification, and were I the responsible engineer I should feel disposed to take off my coat and join up those service cables just to show my independence of Bolshevistic electrical workers. There are many jobbing electricians in quite a small way of business who derive a living by the fruits of their own individual efforts; is the right of these men to a livelihood to be at the discretion of Labour extremists of the type who are responsible for the Hackney incident?

There is reason and common sense in all things, even in labour disputes, but I have no use for the tactics which are adopted by present-day extremists. If they had their way nobody would be free to earn an honest livelihood and we should soon descend to the conditions of Red Russia with its compulsory labour and misery. It is incidents such as that above referred to which make one marvel at the ease with which large masses of otherwise intelligent workers will place themselves in the power of and slavishly obey the behests of fanatics whose ulterior motives will not bear investigation. I cannot conceive that any honest right-thinking wireman or electrical worker would knowingly lend himself to such a creed, and the more these cases are ventilated the better for the well-being of moderate and intelligent Trades Unionism.

Electrical Vehicles—An Advantage.

Users of electric vehicles, both present and prospective, will be interested to learn that they possess an added advantage over their petrol and steam-driven competitors in the matter of taxation. According to a decision recently given by the Law Officers to the Crown, the owner of a commercial electric vehicle may pay taxation on a horse-power basis if desired. This means that the tax on a 3½-ton electric vehicle, as laid down in Sec. 6 of the Second Schedule of the Finance Act of 1920, is £6 per annum, as against the £28 payable in respect of a petrol vehicle of the same carrying capacity. This represents a clear saving of 8s. 6d. per week per vehicle, an important consideration, especially where a number of these vehicles are in operation.

Killing the Goose.

We are all rather annoyed with the miners to-day, but nevertheless we manage to carry on very well indeed, and this prolonged strike has at all events served to bring home to the collier the fact that the country can get along without him for quite a lengthy period when put to it. A tremendous incentive has been given to the various schemes for adapting natural power and alternative fuels to the needs of mankind, just as the war and its many pressing needs stimulated our national inventiveness. The latest reports show that oil fuel is on trial for the great generating station at Lots Road, which supplies the energy for London's Underground Railways, whilst some large Scottish tweed mills have abandoned coal for all time and adopted water power.

These and other indications point to the beginning of the end of the age of coal. Hitherto our dependence upon this national mineral for all our industries has been too absolute, and it is unthinkable that the nation should remain indefinitely at the mercy of the coal-fields. Up to a point, coal is worth what it will fetch in the open market, but when the cost of coal reaches a figure at which it pays better to import the foreign article, the consumption of the British mineral is no longer a practicable proposition. This is the rock upon which the miners divide with the rest of the community to-day, and no amount of pooling, subsidising, nationalising or robbing Peter to pay Paul can alter such an elementary economic law.

Incandescent Lamps— A Tip to the Manufacturers.

One or two recent experiences indicate that the makers of British lamps have yet something to learn before they succeed in turning out a thoroughly reliable article. It may be carelessness in method, lack of factory organisation, or indifferent inspection of the finished product, but in two or three cases lately the preponderance of solder on the contact plates has prevented the insertion of a lamp in a standard bayonet holder. In another example the sudden failure of a comparatively new bulb was traced to a dry joint between the leading-out wire and the contact plate. In yet another lamp a length of bare copper wire was left protruding between bulb and the edge of the bayonet cap.

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I am not very familiar with the process of mounting the caps, but from inspection of the faulty lamps it would appear that the leading-out wires are simply threaded through the thin contact plates, which are pierced to receive them, and subsequently "tacked" with solder at the point where they pass through. This is quite all right in theory, but when you attempt to solder a thin copper wire to the thin edge of a brass contact plate, unless great cleanliness is observed and the soldering process very efficiently supervised, numerous cases of dry joints are almost bound to occur. The tendency to pile up the solder on the actual contact surface is evidence of this possibility and of an endeavour to counteract it.

The general idea would appear incorrect; if circumstances permit the soldering should be effected at the extreme edge of the contact plates and a flat clean metal surface left to establish connection with the tips of the spring-loaded plungers in the lampholder. One never experienced this trouble in the older types of lamp, and it would appear to have its origin in the introduction of the vitreous cap, which is presumably a complete component before its attachment to the sealed bulb, so that the soldering *must* be done on the exposed surfaces of the contact plates. It is only fair to add that the troubles complained of were mostly experienced with miniature bayonet caps, but the fact remains, and a vital though minor principle of manufacture is at stake. The lamps in question were of a well-known brand, made in this country.

The Lighting of Ships.

There is something to kindle the imagination in the problem discussed at the last meeting of the Illuminating Engineering Society—the lighting of ships. To town-dwellers provision of artificial light is accepted as a commonplace. In our homes light is now comparatively abundant, and in the streets of any town of consequence there is at least no real difficulty in seeing one's way about. A ship, however, is an isolated unit with its own more or less limited supply of light, and surrounded often by impenetrable darkness.

Seeing that, as Mr. Jones remarked in his introductory paper, only 1-2 per cent. of the total energy generated on large ships is used for lighting, there should be no real difficulty in providing adequate lighting in such cases. Work in the hold is necessarily dependent almost entirely on adequate artificial light; in the men's quarters comfortable lighting can do much to enliven their leisure; in all parts of the ship lighting has obviously a direct relation to safety.

The most striking thing emerging from this discussion is the comparatively small amount of illumination information available on ship-lighting. Its characteristic problems have not been studied and discussed in the same way as lighting problems met with on land. There seem to be available few schedules of the amount of illumination required for different purposes, such as have been prepared, for example, in connection with factories. Mr. Jones' paper breaks new ground and provides a starting point for discussion.

I notice that the view was expressed that some of the values of illumination recorded, even on large ships, were unduly low, and it is probable that in the smaller vessels they are often quite deficient, judging by standards now adopted in other fields of lighting. I hope that the Illuminating Engineering Society will continue to investigate this branch of illumination with the co-operation of the Admiralty and the Mercantile Marine Service Association, representatives of which took part in the discussion.

ELEKTRON.

ELECTRICITY DISTRICT No. 2.

Following close on their decision concerning the Mersey and West Lancs Electricity District, the Electricity Commissioners have announced their decision concerning the North Wales and Chester Electricity District. As a result of the recent hearing at Llandudno, where evidence was given by the Chester Corporation, and by the North Wales Power and Tractor Co., Ltd., the area provisionally determined has received general assent, and the company's scheme approved. A joint electricity authority is necessary for local supervision, etc., but "the best interest of the district would be served by the delegation or transfer by the Joint Electricity Authority to the company, of its powers of supply with certain exceptions."

In settling the representation on the Joint Electricity Authority, the Commissioners will give due consideration to the proposals embodied in the scheme submitted by the Chester Corporation, and to the representations made by various local authorities, but they will have regard to the *necessity* for constituting a body which will *not be too large* to be efficient.

The company's scheme provides for the utilisation of the water power resources of the western area by the improvement of Cwm Dyli, the further development of Dolgarrog, and a new and extensive development at Maentwrog.

The Chester Corporation scheme (not accepted) provided for (a) development of a series of low-fall water power stations (without storage) on the River Dee between Llangollen and Erbistock; (b) the establishment of a new steam generating station on the Dee estuary; (c) the temporary utilisation of supply from H.M. Factory, Queensferry [this to be used temporarily, as we have already stated]; (d) the establishment of a small water power station in the Vale of Clwyd [this may be developed later]; and (e) ultimate co-operation with the company for a large supply from their hydro electric system.

The Commissioners consider that (a) it would be impracticable at the present time to develop low-fall water power stations on the River Dee; in the event, such development would have necessitated a stand-by steam plant for ensuring the reliability of the supply; (b) the erection of a coal-fired station on the Dee estuary is unnecessary, and the cost of generation at such a station would compare unfavourably with that of a supply from the North Wales hydro electric system; (c) no definite proposals are included for the full development of the water power resources of the western part of the district.

Moreover, the scheme, which provides for the establishment of a joint electricity authority consisting of representatives of local authorities and bodies prepared to accept financial responsibility, failed to secure adequate public support.

Preston.—The Finance Committee have had under consideration a report of Mr. J. A. Robertson respecting the purchase of the undertaking of the Nat. Elec. Supply Co. and the provision of a new generating station on the south side of the River Ribble. The report has been adopted and an application recommended to the Commissioners for a special Order authorising the Council to supply electricity.

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THE FLOODLIGHTING OF POSTERS.

We are now able to illustrate the poster outside the entrance to Olympia lighted by B.T.H. floodlight projectors during the run of the recent "Efficiency" Exhibition. Such a scheme of poster lighting obviously has augmented advertising value, and it is gratifying to learn that the cost is not excessive. The poster in question measures 55 ft. long by 15 ft. high, and was lighted from five projectors, each equipped with a 1,000 watt Mazda gasfilled lamp. The projectors were arranged in a single row on the roof of a shed in the Olympia grounds, and were 12 ft. from the pavement. It is noteworthy that there was an entire absence of glare, though the intensity of illumination was

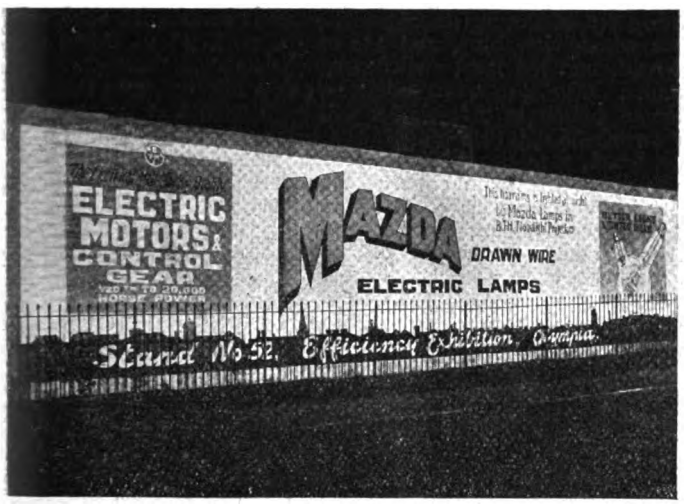


FIG. 1.—POSTER ILLUMINATED BY B.T.H. FLOODLIGHT PROJECTORS.

perhaps twice as high as would usually be considered necessary. Moreover, no direct rays impinged on persons or vehicles in the roadway.

The projector consists essentially of a sheet steel cylindrical casing equipped with a powerful mirror reflector, and is designed for use with the gasfilled type of incandescent electric lamp. The lampholder can be moved in three directions, so that it is a simple matter to adjust the focus and change the shape of the beam. For use on the ground a

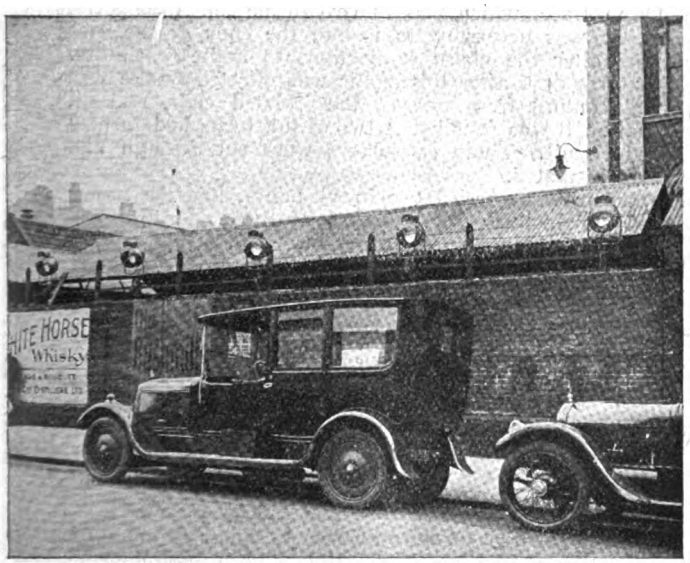


FIG. 2.—DAYLIGHT VIEW SHOWING ARRANGEMENT OF THE PROJECTORS.

tripod mounting is supplied; while in the cases where it is desired to fix the projector to some portion of a building the universal bracket, faintly discernible in the illustration, should be used. Both forms of mounting are adjustable in either horizontal or vertical directions. The casing of the projector is, of course, weatherproof. It is not always practicable to place the projectors exactly opposite the object to be illuminated, and in many cases municipal by-laws would preclude (quite unreasonably) the projection of light across a public thoroughfare. Equally good results may, however, be achieved by fixing the projectors on an adjacent building, or above or below the lighted surface. In such cases, where the angle of incidence of the beam is abnormal to the surface, the area of illumination will be elliptical in form instead of circular, and this fact must be considered in spacing the units. The Mazda poster outside Olympia might, for example, have been lighted by means of projectors placed on the ground at either end, and as far in front of the hoarding as the railing would permit. In this event, two, or perhaps three, projectors, quite closely together, would have been required at each end, and uniformity of illumination could have been attained by directional adjustment of the several beams.

Full information as to the installation and use of floodlight projectors may be obtained from the illuminating engineers of The British Thomson-Houston Co. Ltd. (Rugby, and 77, Upper Thames Street, E.C.4). These engineers have made a study of the many problems involved in the application of floodlighting to spectacular and publicity purposes, and have compiled and tabulated the data necessary for the calculation of distance, spacing and illumination intensity. This information is freely at the service of engineers, contractors, advertisers, and hoarding proprietors who are interested in making the poster work overtime.

LICENSING OF COMMERCIAL ELECTRIC VEHICLES.

It is now stated by the hon. sec. of the Electric Vehicle Committee of Great Britain, on the authority of a letter received from the Roads Department of the Ministry of Transport, that owners of commercial electric vehicles, irrespective of the unladen weight, should, when applying for a licence, apply under A.1. (8) of form R.F. (1) and should decline to apply on form R.F.4 (A). They should state that they intend to use the vehicle for other than solely trade purposes.

The letter in question states that a vehicles, "whether electrically or otherwise propelled, weighing more than 8 cwt. unladen which is constructed or adapted for use and used solely for the conveyance of goods in the course of trade is chargeable with duty based on its unladen weight in accordance with par. 5 of the 2nd Schedule to the Finance Act. The Minister has, however, been advised that where a vehicle which is constructed and adapted for use for the conveyance of goods and is used for other purposes in addition to the conveyance of goods in the course of trade the owner is entitled to obtain a licence under par. 6 of the 2nd Schedule to the Finance Act, 1920, as the vehicle is not used *solely* for the purposes mentioned in par. 5 of that schedule."

Par. 6 referred to reads as follows: "Any vehicles other than those charged with duty under the foregoing provisions of this schedule:—Not exceeding 6 h.p. or electrically propelled, £6. Exceeding 6 h.p., £1 for each unit or part of a unit of h.p." It is hardly surprising that it needed further elucidation.

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RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 117.

The construction of stone cellular type switchboards is not generally understood. Please can you give me some idea of the contents of a cell for, say, a generator panel? What safety and protective devices are necessary to make the cell foolproof?—"TRANSFORMER."

QUESTION NO. 118.

What is the principle of operation of auto transformers for starting induction motors? Is this method to be preferred to the ordinary starter, and is it cheaper?—"STATOR."

(*Replies to Questions Nos. 117 and 118 must be received not later than May 28, 1921.*)

Answers to Questions.

QUESTION NO. 114.

The second prize (5s.) has been awarded to Mr. G. Pinker, Reculver, Litchfield Road, Sutton, Surrey, for the following reply:—

Shunt motors are favoured as they run at approximately the same speed under varying loads, making easy, stopping level at the floors, etc.

The standard type of electric lift gearing comprises a worm and wheel, enclosed in oil bath with magnetic brake on the worm shaft, the magnet, when energised, holding the brake off. The drive is often by V wheel with two or more steel wire ropes. The counterweight should balance the cage and half the full load. The motor should be coupled direct to the worm shaft and lined up dead true and mounted on a rigid bed plate.

The controller is a most important part of the equipment and must start, stop and reverse the motor by the simple movement of a hand rope, or a self-centring switch, usually in the cage or by push buttons, the latter method being rather complicated. Controllers are made as separate units by several firms. To fully describe them would occupy much space and require detailed drawings; however the following details will assist "Floor."

The hand rope controller consists essentially of a throw-over switch with double pole and reversing contacts for the armature currents, and contact for brake, shunt and rheostat solenoid. The rheostat to be automatic in action with dashpot regulation. The hand rope passes up through the cage, and stops clipped on to the rope are pushed up or down as the cage travels, and thus stops the lift at top and bottom of its journey.

A much better type is the car switch controller, especially if the travelling speed is 100 or more feet per minute. A simple form of this type comprises two solenoid operated switch panels, one for up and one for down. These switches handle the main armature current and contacts are fitted to same for the brake magnet, shunt windings, rheostat solenoid and the electrical interlocking; the last named must be so arranged that the swiches cannot both be closed together, and neither can be closed unless all resistance is in the armature circuit. The shunt current must of course not be reversed and there must be a kicking coil to take the shunt discharge. The rheostat is operated by a solenoid with an adjustable oil dashpot to ensure slow cutting out of the resistances. The car switch would have three wires, viz., Line, and one to Up, and one to Down solenoid, and the limit switches can be fixed in these two circuits. Obviously when a limit switch is knocked open the solenoid switch in that circuit will drop open even if the car switch be still held on. If the lifting ropes are wound on a drum, then for safety there should be a screw cut-off, which opens the main circuit. Should the ordinary limits fail with V sheave drive, if the limit switches do fail, the lift will not overrun, as the ropes slip in the groove if either the cage or weight pitch on the bottom floor.—G. PINKER.



HINTS ON LOCALISING AND EXPEDITIOUS METHODS OF REPAIRING FAULTS IN COLLIERY A.C. PLANT.*

BY E. CUNNINGHAM.

(*Continued from page 235.*)

A motor of 70 h.p., 3,000 volts, 420 revs., 50 periods, slip-ring, driving an endless rope haulage drawing main mine to pit bottom developed a short-circuit through earth in two bottom coils of the stator. The stator winding is a hand-wound double-coil type with three slots per pole per phase and the total number of slots in stator is 126 This motor is mounted on a foundation 3 ft. 2 in. above the floor level to suit the gearing, and the distance between the top of motor and the roof is only 13 inches.

From this it will be seen that to have drawn the motor out would have taken a considerable time, and therefore it was decided to keep the motor running if possible until such times as it could be replaced without loss of time.

As it was impossible to get into the part where the short had taken place, which was in two inside coils in opposite phases, it was necessary to isolate the ends of the two coils and alter the phase connections to make continuity. Two or three days after this repair was effected smoke was observed coming from one of the isolated coils, and on examination it was found that two of the turns had formed a closed circuit. These conductors were cut through and the ends insulated.

The repair was carried out in 1½ hours, and the motor operated satisfactorily for a period of three months until we had a replacement ready to put in.

A 600 k.w. turbo-alternator, speed 3,000, volts 3,000, amps. 144, cycles 50, was on load when the power in the H.T. side suddenly failed. On examination it was found that both excitation fuses had blown at the switchboard. These fuses were renewed and the excitation voltage adjusted to 80 volts, and on closing the double pole switch and single pole filled switch, the D.C. ammeter showed a reading of 100 amps., but the H.T. A.C. voltmeter registered zero.

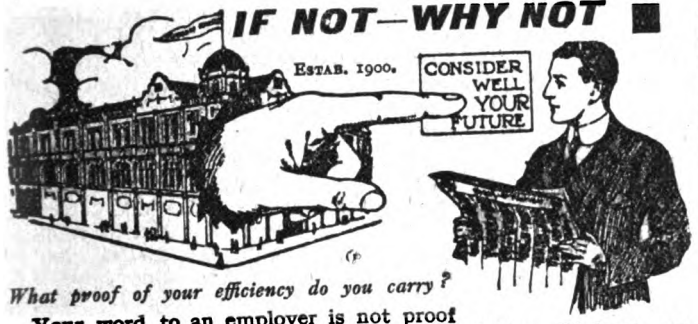
A test was made to locate the trouble and to see whether the fault was in the inductor windings or in the external circuit.

* Paper read at a meeting of the Lothians Branch of the Association of Mining Electrical Engineers, Edinburgh, on November 27 With acknowledgments to *The Mining Electrical Engineer.*

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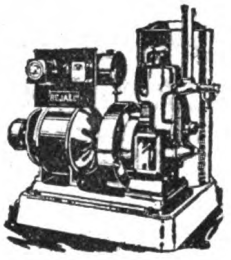
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The slip-ring brushes were lifted and isolated from the rings, and on closing the D.P. switch and field switch the reading on the d.c. voltmeter was 90 volts, and the reading of D.C. ammeter was zero.

This proved the circuit up to the brush holders, so the fault was apparently in the inductor. An insulation test with the megger taken from the slip rings gave a zero reading. As the ohmic resistance of the rotor winding was known to be 0.55 ohm under normal conditions, it was decided to check this by Ohms law. A two-volt accumulator was connected across the two slip-rings with an ammeter in series with one of the leads and a voltmeter connected across the accumulator terminals. On making the circuit the following readings were taken:—Voltmeter 0.5, ammeter 27 amps., and by Ohms law this equals $0.5/27=.018$ of an ohm. The rotor was then drawn and mounted on two strong trestles.

The connections from the winding to the slip-rings were opened and the slip-rings tested to earth and between rings, but the tests showed the rings to be in order. In this type of two-pole inductor the ends of the winding projecting outside the core are enclosed in a brass and steel cylindrical ring which is fixed to the core end plate by a right-handed screw, four threads to the inch. Copper radiators are placed between each coil which is composed of two slots. One of the writer's assistants very wisely thought of testing these radiators with the megger and found that all the radiators at one end of the rotor had an insulation resistance of 50 megs to the metal work. On the other end, which was the coupling end, two radiators in one pole showed an earth, and one radiator in the opposite pole also showed an earth. From this it was presumed that the fault was at this end of the winding. The next step was to remove the cylindrical ring, and as it fits very closely over the winding it was thought advisable to try and soften the winding to avoid damaging the insulation on the coils. This could not be done electrically, as practically the whole winding was cut out by the short circuit. A few carbon filament lamps were put inside the winding and two blow lamps were played on the outside of the metal tried ring. When there was a fair heat on the ring and windings, an attempt was made to remove the ring by putting eight or nine turns of rope round it, securing one end, and the other end attached to the crane was very steadily pulled up. This method did not succeed due to the rope breaking.

A special clamp was made in halves with projecting ends which were specially strengthened to withstand a good strain (see Fig. 4). This clamp was fitted on the ring and the rotor secured to prevent it turning. On the inside face of the clamp two ½in. rivets were fitted, and these entered into two holes top and bottom in the cylindrical ring. A rope sling from the crane was attached to one end of the clamp and a good strain put on, at the same time the other end was given a sharp tap with a plying hammer. This started the ring, and after one complete turn was made, it turned quite easily by hand. When this ring was removed it was found that on the one pole a short had taken place between the inside coil and the cylindrical ring, but the copper was not damaged to any extent and was quite easily repaired.

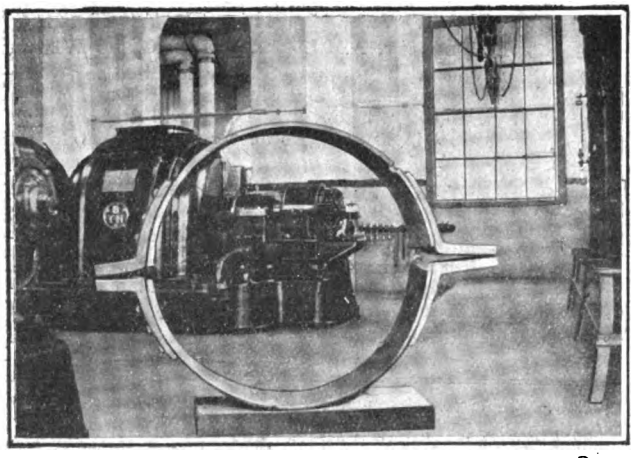


FIG. .4

(To be continued.)

MULTI-SPEED A.C. MOTORS.

Mr. W. E. Bradshaw was in the chair at the meeting of the Institute of Electrical Engineers' Informal Section on the 11th ult., when a discussion was opened by Mr. F. Creedy on "Some Characteristics and Applications of Multi-Speed A.C. Motors." Mr. Creedy said that he proposed to leave aside the cascade and other methods of speed variation and confine himself to the pole changing type as developed by himself. This, he claimed, under certain conditions was the best method obtainable to date. For motors having a gradual speed variation, the commutator motor is the only possible type, and there may be a field for these in sizes up to 50 h.p. in larger sizes: however, they can hardly be considered commercially practicable. He explained in detail the windings and switchings which give the variable speeds and urged that speed ratios of the required duty be carefully studied when the type of motor is under consideration. Broadly speaking the relative advantages of the cascade and pole changing methods depend mainly on the ratio of speeds: some ratios being very complicated for cascade and easy for pole changing. He concluded with acknowledgments to Messrs. F. and A. Parkinson, Ltd., and Messrs. The Electrical Construction Co., Ltd., his licensees, for diagrams and data.

The meeting was hardly prepared for the line taken by Mr. W. E. M. Ayres, who next spoke, but must be grateful to him for opening out the range of discussion. He stated that the call for variable speed motors is often mistaken, and it can be met by simple arrangements of ordinary motors. He told of a 100 h.p. colliery fan of 2-speeds with which it proved better economy to re-wind as a single-speed and run with resistances during the week-ends. He also criticised the Scherbius and Kramer methods on account of the complicated switchgear.

Mr. J. H. Smith spoke from actual experience of the Creedy pole changing machine, which he had found satisfactorily fulfilled duties in connection with heavy machine tool drives previously operated by d.c. motors. He pointed out that in view of the substitution of polyphase for D.C. supply, some form of variable A.C. motor is essential to replace the D.C. variable speed. Mr. W. L. Wreford and Mr. G. J. D. Scott spoke of very definite demands for variable speed motors, notably on printing machines and air compressors. Mr. B. P. Walker also referred to their application to express lift service. Mr. W. E. Bradshaw and Mr. H. Cooch also spoke.

Mr. Creedy, in concluding a most interesting discussion, reminded the meeting that the pole changing A.C. motors, under review, had the same torque at all speeds, while D.C. motors, through weakening the field, need to be built for the maximum h.p. at the lowest speed required, resulting in a larger machine than is the case with the A.C. constant torque multi-speed motor. With regard to the question of power factor, he pointed out that although the P.F. suffered at low speeds, the actual wattless current taken from the line is constant at all speeds. The P.F. reductions are, of course, due to the watt component being reduced at the lighter load corresponding to reduced speed.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

STANDARD MEASUREMENTS (Incorporated Association of Kinematograph Manufacturers. 6d. net).—This 22 pp. pamphlet is an official publication, and represents the standards which they have decided to adopt in this country. It will appeal to everyone who has anything whatever to do with picture theatre work, and as such we can cordially recommend it to our readers in that particular industry. Everyone of them should be acquainted with its regulations. The price is 6d. net, or 8d. post free from this office.

EMPIRE MUNICIPAL DIRECTORY AND YEAR BOOK. 272 pp. and diary, 9½ in. by 7 in. (Proprietors of *Municipal Engineering*, 10s. 6d. net.)—The 39th edition of this comprehensive work is to be welcomed as heartily as the previous annual issues. It covers the past official year of Local Authorities (April 1 to March 31) and gives particulars of Corporations, County, Urban and Rural District Councils in Great Britain, Ireland and the Overseas Dominions, revised to date. The names of the Clerks, Surveyors, Health and other Executive Offices are of especial value to such officials, and also to those doing business with Local Authorities. The article on road construction and materials, engineering and building construction, on lighting, municipalities and motors, sewerage and sewage disposal, public cleansing and waste utilisation, fire prevention, public health, housing and town planning, practical sanitation, etc., constitute not only a review of progress made in each of these depts. of municipal administration during the year 1920, but also a succinct description of all the approved methods, enabling those in search of the most recent information on the subject to obtain it in one volume.

THE "PRACTICAL ENGINEER" ELECTRICAL POCKET BOOK, 1921 (Technical Publishing Co. Cloth 2s. net, best binding 2s. 6d. net).—Besides general revision, the section on wireless telegraphy has been amplified to include the present simple methods of transmission and reception based on the use of the thermionic valve, while a short explanation of wireless telephony has been included. But, in view of the extremely specialised branch of electrical engineering which wireless has become, it is doubtful whether the information is of service to those engaged in it. Some of the sections are in the nature of miniature textbooks mixed with "trade" matter. There are, however, many useful tables, and the whole publication is greatly improved over what it was a few years ago.

DOMESTIC FUEL CONSUMPTION. By A. H. Barker. 160 pp. (Constable, 14s. net).—The bases of this book are various lectures recently delivered by the author, and the idea of editing these so as to present them in a more permanent form than by verbatim reports in the Press and in pamphlet form is to be commended, as but little of "fuel economy" is generally known. The whole aspect is carefully and critically considered from all points of view, particularly that of cost to the user, and, as far as possible, some idea of actual first costs and running expenses of different types of solid fuel burning, gas, and electrical apparatus given both for heating and cooking. The general order of merit with regard to cost, is (1) coal, (2) gas, (3) electricity. This, as is well known, cannot be disputed at the present time, and the figures given stand unchallenged except as to a few per cent. not affecting the ultimate result. The notoriously poor efficiencies of most coal and gas appliances available will be improved to meet the electrical competition, and while reducing the quantity of gas consumed, will, no doubt, become higher in price. The decreased gas consumption will probably tend to keep the price up, while electricity will get cheaper and the cost of electrical appliances fall as they are simplified and standardised, with a resultant gain for the electrical method. Thus we may anticipate that in a few years some of the author's conclusions may need amendment to the detriment of gas. As regards heating and cooking, the information given is of much value to all engaged in the design or sale of apparatus, and electrical salesmen can get, by careful study, many hints as to the lines which should be pursued with prospective customers, though it is doubtful whether the "man in the street," for whom the book appears to have been written, will read it. On the question of lighting little is said, it being conceded that electricity reigns supreme.

Various Items.

Kelvin Medal.—The presentation of the first award of the Kelvin Medal was made by the Rt. Hon. A. J. Balfour, C.M., F.R.S., in the Hall of the Institution of Civil Engineers, to Dr. William Cawthorne Unwin, F.R.S., on Wednesday last.

Electric Supply.—The Manager of the L. & N.W. Railway Co., in a paper to the Manchester Statistical Society, on April 21, remarked that the country was on the threshold of great electrical development, and that the electrification of railways will give a great stimulus to a national system of electrical-power production.

Batti-Wallahs.—At the Batti-Wallahs' lunch, Holborn Restaurant, May 9, at one o'clock, Canon H. Bickersteth Ottley, of the Royal Chapel of St. Katherine, Regent's Park, member of the League of Nations Union, will take the subject of the League of Nations for a short address. Canon Ottley is a forceful speaker, and those electrical men and Batti-Wallahs who attend this function will, we feel sure, hear a very instructive and entertaining oration.

Service Notes.—The big battle cruiser "Inflexible," which took such a prominent part in the Battle of Jutland, and afterwards in the Dardanelles, in the course of which she was severely strained, is to be sold out of the Service. The "Inflexible" was the first battle-cruiser fitted with electrically-driven big-gun turrets. A number of Territorial officers who served with Electric Lights Companies during the great war have been appointed to the Reserve of Officers on relinquishing their commissions.

F.B.I. send Delegation to U.S.A.—With a view to further cementing a happy relationship established some time ago with organisations in America and Canada, propagating similar objects to their own, namely, the improvement of relations between employers and employed, the Executive Committee of the Industrial League and Council have just sent a delegation to America for the purpose of studying economic conditions and ascertaining the possible channels through the medium of which a revival of trade can be stimulated. The idea has received the cordial approbation of large oganisations of employers and employed on the other side of the Atlantic.

Inquest at Aberbargoed.—At the inquest on the body of Evan Wm. Jones, who climbed up an electric transmission line pole and touched the wires, the doctor giving evidence, said that on his arrival the boy was quite conscious. He was bleeding from the nose and mouth, his left foot was off at the ankle, and the right foot and the fingers of both hands were charred to the bone. The boy was practically dead up to the hips, and his arms were practically dead up to the shoulders. His right thigh was also broken, and he passed away about three hours later. The voltage of the transmission lines was 11,000, and the coroner asked the H.O. Inspector (Mr. Kerridge) and Mr. Ivor Williams (engineer to the Powell Duffryn Colliery Co.) if they could not suggest anything to make such wires fool-proof or trespass-proof. Mr. Williams said they had contemplated putting up barb-wire as an effective preventative, and this Inspector Kerridge thought the most feasible and practical. Mr. Williams added they were going to do this straightaway. They had erected the poles to comply with the B.O.T. regulations, and they had been passed by the B.O.T. The live wire in question was one of the best in the country, and had only been in commission a month. One of the companions of the deceased said there was a large danger sign which must have been seen by his companion. A verdict of misadventure was returned.

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Finsbury Old Students' Association.—The annual smoking concert at which nearly 100 Old Students and their friends attended was held at Anderton's Hotel on the 22nd ult. Dr. T. G. Morgan, O.B.E., F.R.S., was in the chair, and all those present voted it a very successful affair, especially the musical programme arranged by Mr. L. M. Clark, A.I.C., F.C.S., which left nothing to be desired. During the evening a Wallis-Jones Medal was presented to Mr. L. Gowing-Scopes, F.C.S., for the best paper contributed during the year by an Old Finsbury Student, his paper being on "The Properties of Some Chlorhydro-Carbons and Their Uses in Chemical Analysis." Old students who are not members of the Association may obtain application forms for membership from the Hon. Secretary, R. F. Guy, 209, Northumberland Park, N.17.

Financial.—The accounts of the Brush Electrical Eng. Co., Ltd., for the year ended December 31, 1920, show a net profit of £191,096, to which must be added £74,726 brought in from 1919, making a disposable total of £265,822. £13,000 is placed to depreciation account; the expenses of the new issue of Ordinary shares made in 1920, amounting to £15,576, are written off; £2,044, being a further 4 per cent. for the year, is paid to the 6 per cent. Second Prior Lien debenture holders; £53,377 added to general reserve, raising this account to £75,000. A dividend of 15 per cent. per annum on the Ordinary shares, absorbing £38,557, will be recommended to the shareholders, leaving a balance of £143,268 to be carried forward, subject to Excess Profits Duty, Income and Corporation Profits Taxes and Directors' additional remuneration.

Trade in Siam.—According to the report on the commercial situation in Siam at the close of 1920, there was a satisfactory increase to £23,430, in the U.K. share of electrical goods and apparatus, apparently at the expense of Holland and Japan. In this branch Sweden was amongst the prominent suppliers with a total of £23,607, due to the purchase in that country of a new turbine plant by a public utility company in Bangkok which is responsible for much of the electric lighting and tram power of the port. The U.S. with £41,175 is responsible for one-third of the total imports of electrical goods, an increase in value on last year's figures, though the actual quantity of goods supplied is reduced by 55,000 kilos. Owing to the partial failure of the harvest the spending power of the country will probably not be so high this year.

Crystal Palace.—An exhibition of great public importance is announced to take place this season, the object being to illustrate the progress made in developing co-partnership and profit sharing schemes, also other means of promoting industrial peace, harmony and progress. The exhibition, which will be called the Co-partnership Exhibition, will be held from Sept. 1, to Oct. 22. It is confidently anticipated that the congress and various conferences to be held in connection with the exhibition will result in lasting benefit to British industry and further popularise a movement which has proved its value in some of the best known and largest business undertakings in the land. Many firms are arranging a day's holiday for their employees during the exhibition, and for their entertainment musical programmes indoors, and sports and games in the grounds, are being arranged.

Trade Notes.

Cinema Traders, Ltd. (26, Church Street, Charing Cross Road, W.1) describe "Triumph" outfits ("focus" type lamps, Mangin mirrors and accessories) for all kinds of optical work requiring from 250 to 2,500 c.p. for low or high voltage circuit. Accumulator sets are supplied, as are arc lamp sets for those who prefer them.

L. G. Hawkins & Co. (114-116, Charing Cross Road, W.C.2), have recently issued No. 3 of "The Electrical Link," containing especially an illustrated description of the "Universal" electric washer and wringer, besides the usual features. The company sent with it some particulars of a newspaper advertising campaign just started and other publicity cards in colour.

Mossay & Co., Ltd. (7, Princes Street, Westminster, S.W.1), have just issued an imposing brochure, chiefly devoted to illustrations of "Orwell" electric vehicles, built by Ransomes, Sims & Jefferies, Ltd., for commercial, industrial and municipal transport. Lead or nickel-steel batteries are fitted. With a full charge, sufficient to give a mileage of about 30 with a useful load of 3 tons, the running cost per mile is given as 6½d. arrived at thus: current at 2d. per unit, 2d.; battery, 3½d.; and tyres, 1¼d.

Higgs Bros.' (Sand Pits, Birmingham) Monthly Magazine for May contains the usual humorous paragraphs as well as a list of motors in stock, and some interesting remarks on the subject of insulation, to which they devote great care in the manufacture of their specialities.

Prideaux and Co., Ltd., Midland Lamp Works, Macdonald Street, Birmingham, are holding a special display of electric and gas fittings at their London Showrooms, 7, Waterloo Road, S.E., under the supervision of Mr. F. N. Wells, and extend a hearty invitation for inspection by our readers.

The Jackson Electric Stove Co., Ltd., have appointed Mr. W. Blogg, of the Sterling Telephone Co., of 8, Park Place, Cardiff, as their agent for the whole of Wales to represent them in their well-known electric cooking and heating apparatus. Mr. Blogg will carry a consignment stock at Cardiff, where samples can be seen and inspected by their Welsh clients.

Owing to the growth of the business of the **Sun Electric Co., Ltd.,** in Ireland, they have found it necessary to move to larger premises. New showrooms have therefore been opened at Gibson's Building, Mill Street, Belfast, where a large and comprehensive stock of electric light fittings and material are available for the use of the trade. The branch will be under the management of Mr. E. B. Prior, as heretofore.

The importance of the scientific lighting of schools is pointed out in a communication received from the **General Electric Co., Ltd.** (Magnet House, Kingsway, W.C.2). The Illuminating Engineering Dept. offers the benefit of its experience by way of advice to those having a direct interest in school lighting. "Superlux," "Doriclite" and "Verilux" are put forward for semi-indirect lighting, which is generally best if a suspension of at least 9 ft. is available.

We are informed by the **Record Engineering Company, Ltd.,** Tutbury, Burton-on-Trent, that the demand for "Silent Record" Engines, "Record" Steam Traps, and other goods this Company manufacture, is so great that they have gone into voluntary liquidation with a view to reconstructing a much larger Company to enable them to meet the demand. We are also informed that practically the whole of the additional share capital is taken up by the present holders and their associates.

The question of the protection of electrical plant in large systems from abnormal stresses imposed on the insulation by surges and other similar electrical phenomena, is fully treated in a revised edition of Bulletin No. 10 recently published by the **General Electric Co., Ltd.** (Magnet House, Kingsway, W.C.2) The subject is discussed under four principal headings: (1) Protection of A.C. circuits, (2) Apparatus of the Condenser Protective systems, (3) Protection of D.C. circuits, and (4) Condenser Protective Gear in typical circuits. The subject is now better understood than it was a few years ago, but is not by any means common knowledge. The treatment in Bulletin No. 10 is as simple and straightforward as possible, and is, therefore, to be welcomed. Typical examples of places where surges may originate are the junction of long underground and overhead mains, a cable entering or leaving power-house or sub-station, a connection from a long overhead line to a large motor, etc.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
MAY 13, 1921.

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ENGINEERING IN RUSSIA.

Mr. J. F. Avila was in the chair at the Institute of Electrical Engineers Informal Meeting on the 25th ult., during the discussion opened by Mr. C. L. Lipman on "Engineering in Russia." The meeting was not as well attended as usual and was the last of the session. The meetings will be resumed at the end of October.

The chairman appealed for early notification of the subjects of papers offered for next session, and introduced Mr. Lipman, who commenced by stating that for the time being the Soviet Government is the only possible Government capable of maintaining public order. The roots of Bolshevism have gone so deep that to extirpate the system hurriedly would only increase the industrial chaos. The Soviets have lately been able to turn from preparations for war, internal and external, to ambitious schemes for the mobilisation of town and village in the peaceful re-establishment of industry, and the engineering industry in particular. This reconstruction has been planned by a body called the Eighth All-Russian Congress of Soviets, which decided to start with the electrification of the most important industrial regions, particularly the coal mining and metallurgical industry of the Siberian, Ural, Moscow and Donetz regions. It is anticipated that during 1921 the Donetz Basin alone will yield 8,000,000 tons of coal and 360,000 tons of pig-iron. The general destitution and the dearth of engineering materials have not permitted progress much beyond the excavating and lay-out of stage, but considerable pioneer work has resulted. A hydro-electric scheme, the Kashir generating station, to supply Moscow and a number of adjacent counties, is being rushed forward day and night, for it is decreed that all factories in Moscow will use electric power. A temporary district station on the Shatour Marshes is helping the Bogorodsky transmission station to illuminate Moscow. The electric station at Sudakovsk Works has been restored, and the works at Tula are receiving the required power. Seven industrial districts of the Moscow Basin are shortly to receive electricity from the Shatour and other stations with the object of obtaining 1,000,000 tons of coal per annum.

In the Petrograd districts electrification is being carried out at an intensified pace; the Ontkin Works are being reconstructed and a new station commenced on the Viazen Marshes. On the River Svir (the Svir Volkhov station) a huge hydro-electric plant is in hand for the supply of the northern districts of the capital. Simultaneously, dredging of the Svir is going on under the Mariinsky Waterway Project of connecting the Volga with the Baltic. In the Donetz Basin the electricity works, reduced to a deplorable state in the fighting with Denekin, are already recovering, and at the end of February last 30 stations with a total energy of 190,000 kw. were working in three of the chief districts, while 3,000 motors of 122,240 total h.p. have been repaired and put to use. In the Kizelovsk coal district in the Ural great efforts are being made to finish the electricity works by 18 months hence.

Nor is it only industrially that electrification goes on. Thousands of cottages are receiving light, and in the Kieff district the workers' quarters are lighted free of charge (!).

Mr. Lipman is a young Russian, himself a victim of the present régime, but his outline of these projects of reconstruction tempted him to forget the disaster Bolshevism has encompassed. The subsequent discussion soon showed much of the regeneration he had spoken of to be still in the elementary stage, as will be appreciated from the following report:—

Mr. Avila admired Mr. Lipman's optimism in looking to a Russia stirring with electric transmission and transport, while we in England had such difficulties with a dense population to justify the operations. He thought Mr. Lipman's address must have increased the interest in Russia of all present. Mr. H. E. Crowcroft, who spoke with some recent years of residence in Russia, told of the German hold in pre-war days on Russian engineering trade, especially in the Baltic Provinces, where the business correspondence might be conducted in German and the rules and specifications were simply translations from German. He asked when might traders interest themselves in Russia and what are the credit arrangements the Soviet Government offers. Mr. F. Pooley regretted that the meeting did not include some of the technical men who generally attend. He pointed out that all were concerned in the enormous demands for engineering goods that would result when a reliable Government could put Russia's materials into circulation. His transactions with Russian engineers has led him to think that there specifications were designed to hamper the English maker and to be of advantage to the German. Other speakers, Messrs. A. H. Allen, W. G. Laird, W. E. Rogers, E. L. Webb, A. B. Eason, W. L. Wreford, B. B. Walker, and Mr. Whitgift, asked for information on the engineering and money standards and of the demand for and status of engineers.

Major R. Grierson asked if there were now electricity acts equivalent to our Authorisations to supply, and any considered scheme for linking up. He also wondered if the Russian had done years of excavating with, say, two years more in which to erect and complete his stations, and whether if he had finally to light the areas free (*vide* Kieff) he would show a profit by Bolshevist finance. He thought it desirable to get young Russians into English works that they might return home with the correct bias. Mr. Crowcroft speaking a second time, said he did not think there was such an entire dearth of skilled labour in Russia as was held: he had seen thoroughly sound jobs carried out entirely by Russians. The Russian engineer was often extremely well trained, but frequently too theoretical. There were no facilities at home for study, and he generally went to Germany, hence his bias for German methods and standards. Russian electrical standards were largely the VDE (Deutschein Verbandforschriften) standards, which are so much more elastic than our I.E.E. standards. Still, he was convinced our first-class materials would yet find a market in Russia.

Mr. Lipman, in reply, told of the disabilities of the native engineer and the compulsion of going abroad to learn. Germany, by her proximity has received most students and had naturally benefited. Further, the German was more complacent and was ready to give long credits, but he did not believe the German influence would hold in the future. The trading agreement with Russia had been signed, and he appealed for sympathy with the only possible Government *pro tem.* He believed that things would right themselves and that the Russian eventually would honestly meet all his obligations.

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ELECTRO-PLATING.

BY C. SYLVESTER, A.M.I.E.E., A.M.I.MECH.E.

(*Continued from page* 196.)

DYNAMO CIRCUITS.

It is hardly necessary to give any details of the design and construction of the plating dynamo from a current collecting point of view, beyond saying that the brushes are made of copper gauze of a sufficient cross sectional area to carry the whole of the current the machine is capable of delivering without overheating, and causing too great drop of voltage. The leads connected to the brushes must, of necessity, in very large plants be very massive and flexible to allow the brushes to be moved on their rocker as necessity demands. The flexible leads are usually connected between each brush bar and a massive bus bar from which the shunt and the circuit breaker connections are taken.

ARRANGEMENT OF PLANT.

The position of the dynamo should be very carefully considered from the fact that the greatest output is desirable. The position of this machine is, therefore, as near to the plating baths as is possible. This is necessary not only from an efficiency point of view but from an initial cost standpoint also. The further away from the dynamo the vats are placed, so it will require much longer conductors. These are, of course, very heavy copper bars, according to the maximum output of the machine, and copper is always a very expensive item.

Although it is necessary to consider the position of each machine in each plant separately, that is taking into consideration whether the dynamo is to be belt or motor-driven, I consider that Fig. 4 illustrates the ideal method

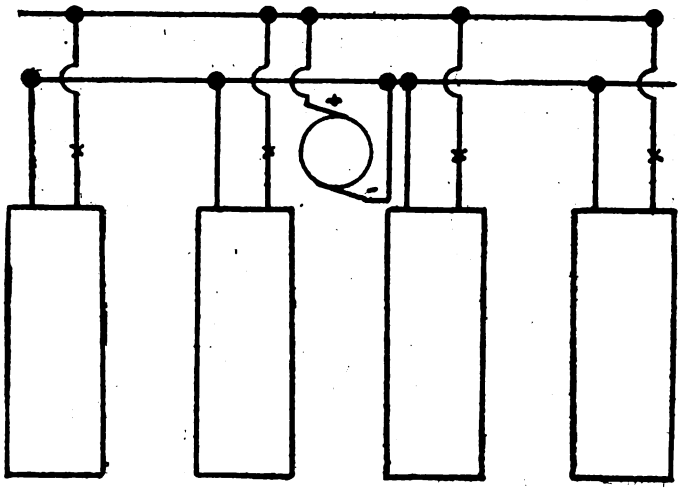


FIG. 4.

of current distribution. Here the dynamo is shown in, approximately, the centre of the plant. From this it will be seen that when the current arrives at the main bus bars it divides in two directions, and each direction is connected to two baths. Here, of course, the main bars between the dynamo and the distributing bars must be of at least twice the cross sectional area of the distributing arms.

This system is only possible where the dynamo is motor-driven, and it will be convenient to fit the motor in any position in the shop. Where the machine is belt-driven, however, the arrangement must be much different. A line of shafting, as a rule, is fitted close to the wall of a shop, due to the fact that the shafting brackets depend upon the wall for their support. Here the position of the dynamo would be as close to the wall, perpendicular to the wall upon which the shafting was fixed, as possible.

BATH SWITCHES.

It is necessary to have some means of making the respective baths *dead* when placing and removing work in and from any bath. This is quite clear when it is remembered that some baths may be plating much larger articles than others, and it is hardly possible to load and empty all the baths at the same time. This calls for the necessity of a switch or some means by which any bath can, as desired, be disconnected for the distributing bus bars. Ordinary switches are not suitable for this work, not only on account of their size and expense, but because of the great "drop" across their contact.

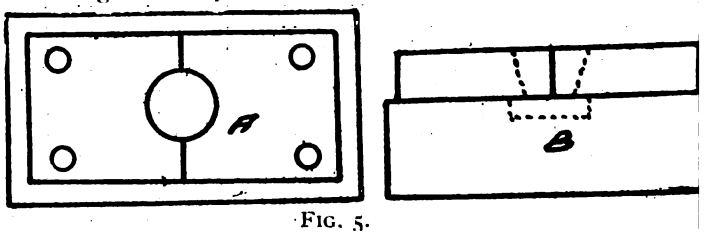


FIG. 5.

Fig. 5 illustrates a special type of plug switch which has been found to be very satisfactory when used on large plating plants. It consists of a slate base upon which is mounted a very thick copper bar. This bar has a hole drilled in its centre, and this hole is tapered to receive a plug. After the plug has been ground into the hole, the bar is cut across the centre of the hole so that the circuit across the bar is completely broken. An ordinary saw cut is quite sufficient for this purpose, because, since the voltage is very low, there is no danger of an arc being set up across the gap.

The plug is made of round copper, upon which a wooden handle is fitted. As stated above, it is tapered to fit into the hole. When placing this plug into the hole, if it is slightly twisted it will keep the contact between it and the two halves of the copper plate quite bright and so the drop of voltage across it is minimised. Fig. 5, A and B, illustrates the construction of the copper bar and slate base in plan and section. The holes shown in A are drilled and tapped holes which will allow the copper bars to be fixed to them. The position of these switches are in one pole only, and preferably at the points marked X in Fig. 4.

CONDUCTOR CONDUITS.

Here, again, the size of plant has to be considered. In small plants it may be possible, and quite convenient, to run the conductors between the dynamo and the baths on porcelain insulators supported by hangers of thin mild steel bar These hangers may be fixed to the ceiling and the conductors may be arranged to drop down on to their respective baths.

In slightly larger plants, or if the use of hangers is prohibited in small plants, the conductors may be run on porcelain insulators fixed to the walls. These insulators may be of the circular or flat type, since all that is necessary with either type is to place a few wooden plugs in the wall so that a wood screw will fix them in position.

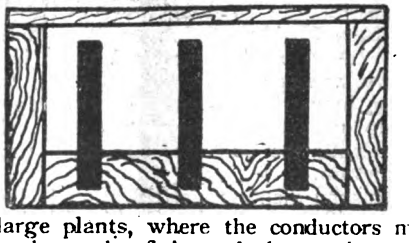


FIG. 6.

In very large plants, where the conductors must be of heavy copper bars, the fixing of the conductors presents a problem which cannot be solved by deciding to fix them on the wall. The most efficient method that I know is illustrated in Fig. 6. This diagram shows a wooden trough, in section, in which three copper bars are placed. Grooves are cut in the wood to receive the bars, and this

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method serves to keep them more or less rigid. The trough is placed on the floor, but is raised from it about 1 in. to allow a flow of air to pass under it. This method is not inconvenient, as would appear at first sight. The main conduit is run quite close to the wall and the branches are taken to the baths from their nearest point.

(To be continued.)

RADIO-TELEGRAPHY AT GREAT HEIGHTS.

Investigations are here described into the causes of many reported failures of aircraft radio apparatus to operate at great heights. It was proved that cold had no influence on the spark, length of wave, or damping decrement. The spark-gap must, of course, be kept clear of snow. The voltage and efficiency of batteries fell off appreciably, but no complete failure was traced to this cause. The superiority of collector batteries in double-walled heat insulating cases was demonstrated.

The effect of the rarefied air on the speed of the generator was negligible, but it was found that the rarefaction had a surprising influence on the operation of the spark-gap. With the normal barometric pressure decreasing corresponding to increasing altitude up to about 5,000 metres, the fall in antenna current was gradual, attaining about 15 per cent. Between 5,000 and 7,000 metres a sudden and considerable fall of 90 per cent. and even more was recorded. Thereafter the current remains practically constant. This phenomenon is fully apparent only with sharply-adjusted resonance. If there is a discord between impulse and antenna circuits the antenna current will not fall immediately with falling pressure, but first rises slightly, and then falls the more rapidly. The resonance curve was found to become flattened in the critical pressure zone, and damping progressively increased.

The remedy suggested is complete airtight enclosure of the spark-gap. (Abstract in the *Technical Review* from the *Jahrbuch für drahtlose Telegraphie und Telephonie.*)

THE "UNIVERSAL" WASHER AND WRINGER.

Awakening interest is now being displayed in this country in electric labour-saving devices, and everything possible should be done to bring good and reliable machines before the public and their use encouraged. Besides vacuum cleaners, heaters and small cookers, the washing machine is a device which will probably appeal most strongly to housewives of ordinary means. A useful device of this type is the "Universal," of which a sectional view is given in Fig. 1. This shows the accessibility of the interior. To use the machine the clothes are placed in the perforated, metal cylinder and are gently lifted and dipped into the water. The cylinder revolves twice one way, then reverses, making 18 complete revolutions per minute. Anything from the most delicate silks to heavy blankets can be satisfactorily washed without wear on the fabric. Six full-size sheets or the equivalent can be washed at one time. Fifteen minutes is usually the period that should be allowed for each "wash." Really hot water is essential and the usual laundry soaps and powders should be used. The "water line" is only about one-third way up the tank, therefore a comparatively small amount of water is required. The whole of the mechanism is encased in an enamelled blue steel cabinet with convenient water outlet.

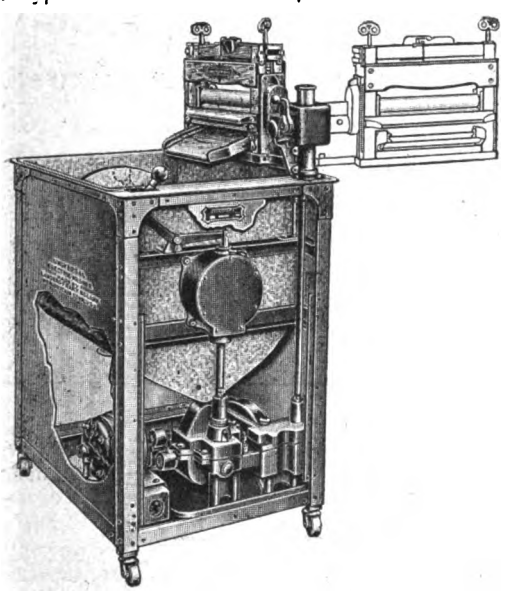


FIG. 1.

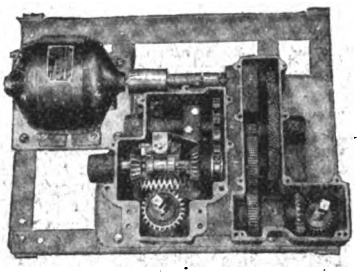


FIG. 2.

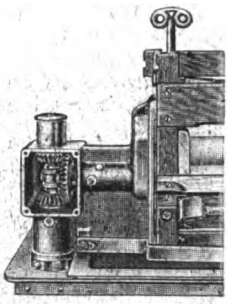


FIG. 3.

Fig. 2 illustrates the motor and main mechanism. The motor is of ¼ h.p., connected by a simple flexible coupling. All moving parts are run in oil, and the whole construction resembles the type of work that is usually found in the best makes of motor-cars. The motor is equipped with the "Universal" patent safety release device as used on the "Universal" meat chopper and coffee mills. This, in case of overload, automatically cuts out and obviates motor burn-outs. The gears and motor are just as noiseless as it is possible to make them.

Fig. 3 illustrates the reversing gears of the wringers; by moving the handle provided from left to right, or vice versa, the gears on either side are engaged. This arrangement is simple, effective, and mechanically sound. As shown in Fig. 1, the wringer can be operated in various positions, four in all. It is fitted with a safety release which instantly removes all the pressure from the rubber rollers, should the necessity arise.

ELECTRICITY SUPPLY AT PRESTON.

Mr. J. A. Robertson, M.I.E.E., in a report to the Corporation on the electricity supply and the acquisition of the Electric Company's undertaking, says among the advantages will be that the capital necessary for development can be raised more quickly by the Corporation, and the latter would have direct representation on a joint authority. "The Corporation," he adds, "are in the fortunate position of having a site close to the borough, in which a modern station could be erected capable of producing electricity at a minimum cost and sufficient for all future demands. The extent of Preston's requirements can be gauged by a reference to other towns with similar industrial conditions. In some towns the consumption of electricity per head of population exceeds 200 units; the averages of nine Lancashire towns depending chiefly on the cotton industry is 127 units per head. In Preston the average is only 22, this being about the lowest consumption of any industrial town in the country. Immediate steps should be taken to construct a new station on the site already acquired on the south side of the Ribble. Allowing a period of two years for construction, the station would be constructed to meet the winter load of 1923-4. In the meantime the plant at Crown Street Station should be used to its fullest capacity. The new station would be

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designed to generate high pressure three-phase current, which would be delivered by duplicate cables at 11,000 volts pressure to Crown Street. The Ribble site is directly open to the coalfields of South and East Lancashire and West Yorkshire. Coal should be conveyed by aerial transporters from the dock railway system, and deposited direct in overhead bunkers in the boiler house. The estimated capital expenditure for the new works is £379,000."

THE LIGHTING OF A FOOD FACTORY.

In planning dairies, bakeries and other buildings where foodstuffs are manufactured and handled, one of the chief points for consideration in designing the equipment is the provisions of facilities for scrupulous cleanliness. In regard to the lighting of such buildings, the inherent cleanliness of electricity as an illuminant is at once obvious, so that in practically all modern food factories electric lighting is specified.

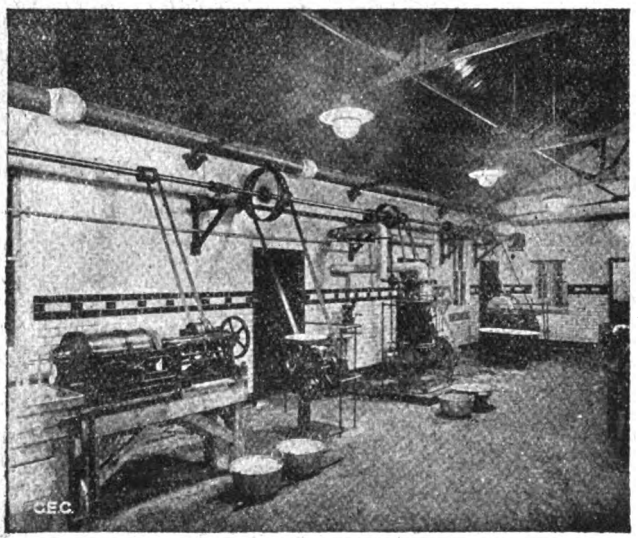


FIG. 1.—A VIEW IN THE MAIN FACTORY.



FIG. 2.—CHEESE STORE.

To the illuminating engineer, the lighting of food factories is a fairly simple problem. The rooms are generally designed on light and airy lines, and the walls are invariably whitened, and are, moreover, subject to frequent cleaning. These light surroundings form ideal conditions and enable good lighting to be provided for a minimum expenditure of current.

The installation is that of Messrs. Henry Thompson and Sons, at Nether Broughton, near Melton Mowbray, and the lighting arrangements were designed by the Illuminating Engineering Dept. of the General Electric Co., Ltd., Magnet House, London, W.C.2, who also supplied the fittings and lamps.

In this factory, which is devoted to the manufacture of pork pies, sausages and Stilton cheese, a well-diffused and uniform illumination was specified, and the semi-indirect system giving an average intensity of 5-foot candles decided on. As will be seen from the illustrations, not only is the diffusion good, but the illumination uniform, every corner being well lighted. Two types of fittings are used, the first in the main bays, which are fairly lofty (Fig. 1), and the second in the curd room and stores where the roof is considerably lower. Osram gasfilled lamps of 200 watts are used in the former, and of 100 watts in the latter.

ELECTRICITY DISTRICTS.

The Local Inquiry into the proposed London and Home Counties Electricty District will be held at the Institute of Electrical Engineers, Victoria Embankment Buildings, on June 14. Schemes have been submitted by (a) the L.C.C., (b) the Conference of Local Authorities Owning Electricity Undertakings in Greater London, (c) the London Electricity Joint Committee (1920), Ltd., (d) the Metropolitan Borough Council of Poplar, (e) the G.E. Railway Co., and (f) the L.B. and S.C. Railway Co.

(a), (b) and (c) are concerned with effecting an improvement of the existing organisation for the supply of electricity in the district and with the formation of a Joint Electricity Authority.

(d) is concerned with effecting an improvement in the existing organisation for the supply of electricity in "East London and District" and with the formation of a Joint Electricity Authority for such district.

(e) and (f) have similar objects to (a), (b) and (c) without the formation of the Joint Authority.

It is announced that the Inquiry concerning the West Riding (Aire and Calder) District will now he held at Leeds on the 18th inst., while the time for receipt of objections, representations, etc., lodged concerning the North Lancs and South Cumberland District has been extended till July 30.

STARTING OF SYNCHRONOUS MOTORS.

It has been proposed in several quarters to combine the advantages of a synchronous motor under running conditions with the starting characteristics of an induction motor by converting an ordinary induction motor into a synchronous motor, when up to speed, by introducing continuous current excitation through the rotor slip-rings. Mr. Lapine, however, in a recent issue of *L'Industrie Electrique*, quoted by the *Technical Review*, attacks the problem from the other side by taking a synchronous motor built on the lines of an alternator and starting it as an induction motor without excitation.

A resistance is connected in each phase at starting, but is afterwards cut out. The slip-rings are first connected to a resistance, and as the motor approaches synchronous speed a resistance in the exciter is gradually cut out so as to introduce the excitation and to pull the machine into synchronism without requiring any of the ordinary synchronising gear.

The B.E.A.M.A.: New Members.—We are informed that ten more firms have been recently elected members of the British Electrical and Allied Manufacturers' Association.

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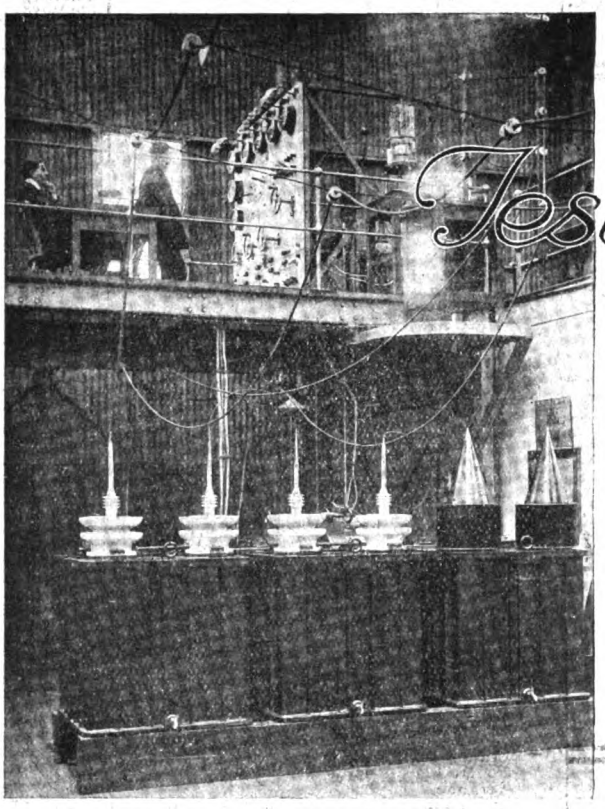
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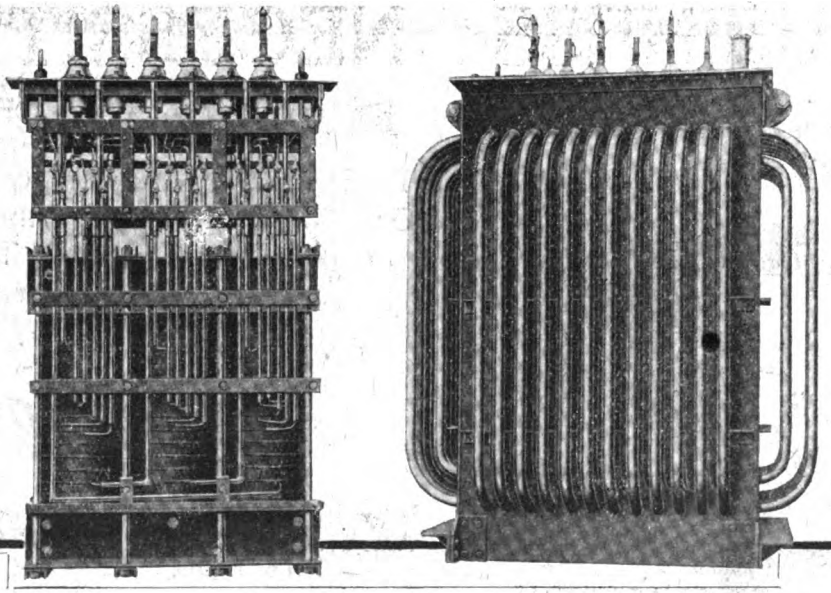


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We specially and particularly ask all interested to note the above, and invite inquiry for any type of Transformer, against which we will quote and supply at same time full detailed specification.

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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 3d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 38-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

The Boomerang.

As most readers are aware, a boomerang is a weapon of peculiar formation which, when thrown at an object, returns to the one who threw it, and may, in certain circumstances, inflict injury upon that person. It is the more gratifying therefore to reflect that most of the extremist acts of Labour to-day are bound, sooner or later, to emulate the boomerang and recoil upon their perpetrators. Such, for instance, will be the case in the Hackney incident, reported in my last week's notes, in which, it will be remembered, certain corporation workmen refused to connect a house wired by a master wireman because he did not belong to the E.T.U. Mr. Forbes Lankester, the North London magistrate, has since delivered his judgment, fining the Hackney Borough Council 5s. per day for nine days, with 20 guineas cost, for default in supplying electric power, owing to the circumstances already related.

This is a trifling sum in itself; but if, as is possible, the Borough Council decide to appeal, an action in which they would receive the wholehearted support of the magistrate, the hearing of the case by the High Court is going to cost a pot of money, which will eventually be reflected in the rates. As electrical workers pay rates along with other members of the population, it will ultimately be up to the revolting trades unionists to contribute to the cost of this mountain which they have created out of such a trivial molehill. It is a great pity the direct actionist of industrialism does not more often realise that everything costs money nowadays, even actions at law based on his own squabbles with his bread and butter.

At the present time there is considerable outcry at the constantly increasing local rates, and it were well for fire-raisers, window slashers, and destroyers of property in general to realise that they pay for the damage in the long run, together with the rest of the community which is more level-headed. You can't have your fun, or even your imagined revenge on society, without paying for it. Every act of damage to property has to be paid for, and, although it does not come directly out of your pocket at the time the act is committed, sooner or later the bill will be presented in the form of increased rates or taxes. It's a fool's game to quibble and squabble over such imagined grievances as that of the Hackney wiring incident. Moreover, it is an extremely bad advertisement for trades unionism. Such incidents do far more harm to the movement than a dozen legitimate labour disputes.

Ebonite—A Warning.

One of the best-known and highest-class electrical insulators is ebonite, or hard rubber, to which it is closely allied. Ebonite is, in fact, rubber minus a considerable proportion of its elasticity, and its constituents and mode of manufacture are similar, including the process of vulcanisation. There is a phase in the process of manufacture of ebonite, however, which in the past has often proved a trap for the unwary, and I have come across numerous instances where manufacturers of electrical plant and apparatus have been let down by failure to appreciate this trap. In order to obtain the smooth glossy surface peculiar to sheet ebonite, metallic foil is used in the manufacturing process as a backing for the plastic sheets, and although every precaution is presumably taken by ebonite manufacturers to prevent it, there is almost invariably an invisible metallic deposit on the surfaces of the finished ebonite.

This naturally detracts from its high insulating qualities by setting up surface leakage, and the experienced maker of any electrical gear embodying sheet ebonite in its constitution, always takes the precaution of removing the surface by grinding or papering, and, if need be, repolishing. Unless this is done there is almost sure to be trouble sooner or later with the insulation of the finished article. It goes against the grain to suspect so high an insulator, and I have known manufacturers to go to endless trouble in an endeavour to fix the blame for low insulation of their products in every direction except the right and less obvious one. Always suspect unworked ebonite, and, especially if a big job is in contemplation where considerable quantities of this insulator will be used, take the precaution of instituting a severe insulation test of all bulk supplies before passing them into the shops for shaping and assembly into the finished article. Incidentally, the ebonite manufacturers might look around for a less troublesome planisher than metal foil.

Dwindling Coal Stocks.

The perceptible diminution in certain well-known coal piles is throwing some interesting light on dark places. I know of more than one boiler-house that is now receiving direct daylight for the first time within memory of its existing staff, the windows having been hitherto obscured by the huge coal piles in the immediate vicinity. At another power station there has been an interesting "find" of rails, stacked away months ago in a corner and forgotten until some energetic coalies started dumping wagon-loads of black diamonds on top of the stack, hiding it from view. Time and again questions have been asked by the powers that be regarding those lost rails, and the mystery has at long last been cleared up by the exposure of the missing scrap underneath a dwindling pile of fuel.

Incidentally it throws interesting light on the very considerable cubic space occupied by large coal reserves now so necessary at all big power stations. Bunkering facilities are one of the power-station engineer's principal difficulties, especially in a crowded district

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where there is not much spare ground available near the station buildings. It is the aim of every "chief" who knows his job to buy his fuel when the market is favourable and pile up as big a reserve as possible against such eventualities as the present coal strike. As a result of the miners' holiday a good many familiar landmarks are altering their shape and overall dimensions, and it will mean several weeks of colliery activity to build them up again to their original contours.

Nickel-Plating—A Mystery.

There is a mystery attaching to nickel-plating which I have never fathomed. It concerns the relative colours and finishes of American and British nickel-plating. Compare any two nickel-plated articles of American and British origin and the difference will at once be apparent even to the most casual observer. The American or Canadian finish is infinitely whiter and has a better sheen than that obtained in this country, even under the most favourable conditions. I first noticed it in the early days of the cycling boom, when American bikes were competing with the highest-grade Coventry productions. It is the same to-day with motor-car fittings and the electric heating appliances and other plated products which come into this country from America. We cannot touch their plating for appearance and colour. What is the real reason? I have asked many experienced electro-platers, but they have never been able to explain it. I am inclined to attribute the phenomenon to atmospheric influences, or possibly the water has certain natural characteristics which affect the solutions prepared from it. Can any reader throw light on this subject? ELEKTRON.

STREET LIGHTING.

LONGITUDINAL LIGHTING LANTERNS.

The older forms of street lighting units were simply light sources mounted at a certain height and spaced more or less arbitrarily. Later it was realised that the ideal lighting would only be attained if the whole roadway were practically uniformly illuminated. The problem has been scientifically studied, and by carefully spacing the units, erecting them at a height determined by calculation, and by using light sources of proper illuminating value in scientifically designed lanterns, it is now possible to approximate to the ideal—but at considerable cost, as in many cases total re-arrangement of the previous order is necessary. A simple and effective device for use in existing lanterns, as well as in new ones, has however recently been devised and patented by Mr. Haydn T. Harrison and tried with most satisfactory results at Canterbury. The lower hemispherical luminous flux from the light source is not interfered with, but the upper hemispherical luminous flux which is generally wasted or only partially used is collected by a specially designed reflector into a solid angle of desired divergence; this angle being very small compared with an angle of 180 degrees, the light concentrated is equivalently powerful. This powerful light would normally shine directly below the lamp, but is directed up and down the street by two or more plane mirrors radiating from the light source, thus interfering very slightly with the direct rays. The angles of these mirrors is adjusted so that the powerful light begins to fall on the road or street at the distance where the direct light fails to bring the illuminarion up to the standard required, and increases in power until it meets the light from the adjacent lamps, thus ensuring a more even illumination throughout the street and avoiding all dark patches. The angle of the plane mirrors is adjustable for various distances between the lamps, likewise the angle of dispersion is adjustable for various widths of roads or streets.

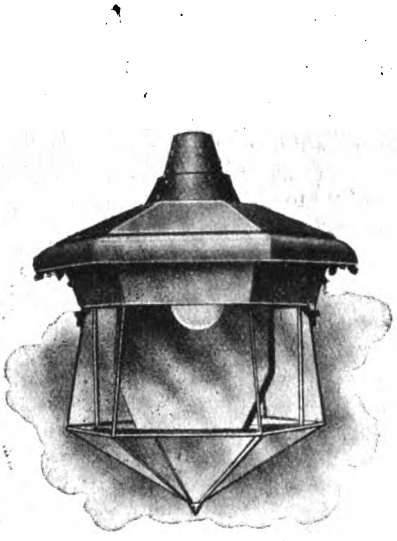


FIG. 1.



FIG. 2.

Fig. 1 shows the "Canterbury" type lantern and Fig. 2 the "Adapter" type—the first being one of several types intended to replace existing high power lamps, flames, arcs or extra high pressure gas lamps. They are designed to take up to 500-watt gasfilled electric lamps; but as with 300-watt lamps the lanterns give from 3,000 to 7,000 c.p. on the distant rays, it is rarely that more than 300-watt lamps are required. Fig. 2 shows a side street fitting in an existing gas type lantern. A 40 to 100-watt lamp is sufficient in this fitting.

A leaflet dealing with the system has just been issued by the Electric Street Lighting Apparatus Co. (The Foundry, Canterbury), who with the General Electric Co., Ltd., hold the sole licence to manufacture under Mr. Harrison's patents.

MINERS' ELECTRIC CAP LAMPS.

The Miners' Lamps Committee, as a result of its investigation into the question of the safety and practicability of Miners' Electric Cap Lamps, has advised the Secretary for Mines that he should approve such lamps for general use in mines under the Coal Mines Act, subject to each type of lamp passing the necessary official tests as to its safety and mechanical soundness. The type of Cap Lamp made by Messrs. Oldham and Son, Limited, Denton, near Manchester, having passed these tests and been put through a series of practical trials in coal pits extending over many months, has been approved by Order, dated April 20, made under Section 33 of the Coal Mines Act, 1911. Applications for the approval of types of Cap Lamp of other makes are now being dealt with by the Mines Department. The Order of April 20, which is now in the press and will be published shortly, also approves the following new types of Miners' Electric Hand Lamps:—

Pearson Ni + Fe Lamp, made by the Alkaline Miners' Lamps, Limited, Stratford.

Patterson Type G-1 Lamp, made by Messrs. Patterson and Company, Newcastle-on-Tyne.

The Federation Lamp, made by the Federation Lamp Company, Sheffield.

The Adams Lamp, made by Messrs. Adam Brothers (Longton), Limited, of Longton, Staffs.

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TARIFFS.

The two papers and discussion, extended over two evenings, at the Institution of Electrical Engineers, dealing with tariffs—the papers being by Mr. J. R. Blaikie and J. W. Beauchamp—ended, perhaps, in a rather unexpected manner. The underlying argument was that we have reached the limit of usefulness of the flat rate per unit as provided for in Electric Lighting Provisional Orders, and that the time has come when there should be a change to a system based on a fixed charge per kw. per annum, plus a running charge per unit for all current consumed. As things stand at present, a flat rate is what may be termed the legal charge, and, although other tariffs may be offered as alternatives, consumers cannot be compelled to adopt them. Everybody seemed to agree that the day of the flat rate has gone, but, on the second day of the discussion, the trend of thought turned largely in the direction of some steps being taken to relieve the industry from the present restrictions as to methods of charging. The precise details of any particular two-part tariff faded rather into the background, and the possibility of inducing the Electricity Commissioners to aid in abolishing the flat rate took pride of place. The matter is an extremely important one for the whole industry, and not least to the manufacturing side, yet the attendance at the adjourned discussion was disappointingly small. The Institution has sent more than one deputation to the Electricity Commissioners with the object of obtaining the insertion of clauses in the No. 2 Electricity Supply Bill, but so far —in the words of Mr. Ll. B. Atkinson, the President of the Institution—without any success, for the reason that political considerations are too strong for the Commissioners, who cannot be accused of a want of appreciation of the needs of the industry.

The alternatives put forward are very much increased maximum prices under present conditions, or the right to charge upon a two-part system without any option on the part of the consumer. What is wanted is some tariff which will induce the general domestic user to adopt a variety of electrical apparatus, which he cannot do with a high flat rate, originally designed for lighting. Whilst the necessity for two meters and separate wiring systems exists, the average domestic user will not go much beyond lighting; but, by making the position easier and simpler for him by giving inducements to increase the use of electricity—and that is only possible with an attractive tariff and one meter—a vast improvement would be seen in the industry on the domestic side. No one tariff can be desired to suit all conditions, but once the principle is agreed upon and given legislative force to, the rest would be, comparatively speaking, plain sailing. The position we seem to have reached, especially in the smaller towns, is that new consumers are not being encouraged, because, if they are small, they do not pay at present rates. The efforts are rather in the direction of encouraging existing consumers to increase their uses.

Blackburn.—The Electricity Committee have decided not to grant the applications from Billington Parish Council and Oswaldtwistle U.D.C. for the supply of current from the new station. A committee was appointed to deal with the application of Blackburn R.D.C.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 117.

The construction of stone cellular type switchboards is not generally understood. Please can you give me some idea of the contents of a cell for, say, a generator panel? What safety and protective devices are necessary to make the cell foolproof?—"TRANSFORMER."

QUESTION NO. 118.

What is the principle of operation of auto transformers for starting induction motors? Is this method to be preferred to the ordinary starter, and is it cheaper?—"STATOR."

(Replies to Questions Nos. 117 and 118 must be received not later than May 28, 1921.)

THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

BY SIR WILLIAM NOBLE, M.I.E.E.

(Contined from page 248.)

Under the best conditions of a cable circuit the simple differential repeater may be operated to give a transmission improvement equivalent to the suppression of 16 miles of standard cable in a circuit having an equated length of 30 miles of standard cable.

It has been found generally impracticable to use the simple differential repeater for tandem working, owing to the effects of reaction between repeaters at adjacent stations; consequently its use is limited to circuits which are not liable to be switched through to other circuits containing repeaters.

This limitation led to the development of the double differential repeater shown in skeleton form in Fig. 6. In this arrangement the line circuit is divided at the repeater station; each side is terminated in a duplex repeater and balanced by an artificial line designed to represent as nearly as possible the electrical characteristics of the actual line over the range of speech frequency. In practice, absolute balance is not obtained between the actual and artificial lines at all frequencies, but the balance can be made sufficiently accurate by the use of simple apparatus to permit the operation of as many as four repeater stations in tandem, each giving a transmission improvement equivalent to the suppression of 16 miles of standard cable. The minimum residual transmission equivalent of a repeatered circuit using repeaters of this type singly or in tandem is found in practice to be about 12 miles of standard cable.

The problem of constructing artificial balancing lines for telephone repeaters has necessitated an exhaustive study of the impedance characteristics of line circuits.

It was soon found that sudden changes in the composition of a telephone circuit due, for example, to unevenly spaced

* Paper read recently before the Inst.E.E.

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loading coils, the insertion of sections of line with different conductor resistance, electrostatic capacity, or insulation resistance per mile, introduce irregularities in the impedance/frequency characteristics of the circuit of such a character as to make it practically impossible to obtain an absolute balance between the two sides of the repeater circuit. One of the objects of the improvement in line construction, therefore, is to obtain a homogeneous circuit having impedance/frequency characteristics free from irregularities. This condition is obtained by so designing the circuit that the resistance, capacity, leakance and inductance shall be uniformly distributed throughout the length of the circuit. For satisfactory transmission of speech the circuit should also be practically "distortionless." A distortionless circuit—(*a*), transmits all the important speech waves with equal attention; (*b*), maintains the phase relationship between the various frequencies; and (*c*), its impedance is constant over the important frequency range. An artificial balancing line for such a cable would be a plain resistance whose value could be predetermined.

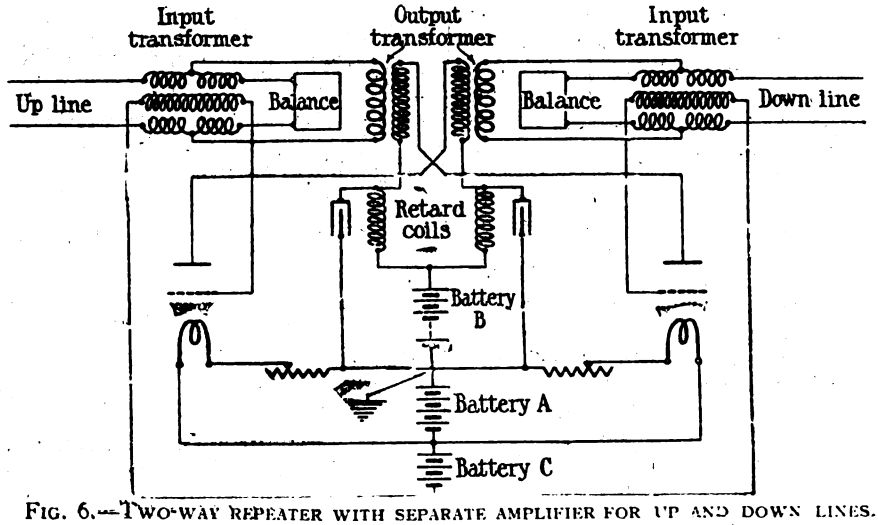


FIG. 6.—TWO-WAY REPEATER WITH SEPARATE AMPLIFIER FOR UP AND DOWN LINES.

Hitherto these conditions have not been obtained in practice, especially condition (*c*), and at present it is not practicable to predict accurately the impedance/frequency characteristic of any circuit. It is therefore necessary to measure the impedance of each line, if maximum efficiency is to be obtained from a repeater, to enable the balance to be calculated.

The impedance characteristics of line circuits are obtained from alternating-current bridge measurements made at frequencies ranging from 350 to 2,000 cycles per second. A thermionic valve arranged as an oscillation generator is used as a source of power for the bridge, which is shown diagrammatically in Fig. 7.

Fig. 8 shows the results of measurements on a loop of 70-lb. conductors loaded with 135 mH coils at intervals of 2.6 miles. It will be seen that the mean curves for both the resistance and reactance components rise with frequency. This is due to the loading coil nearest to the office from which the measurements were made being too near to that office, and also to the effective resistance of the

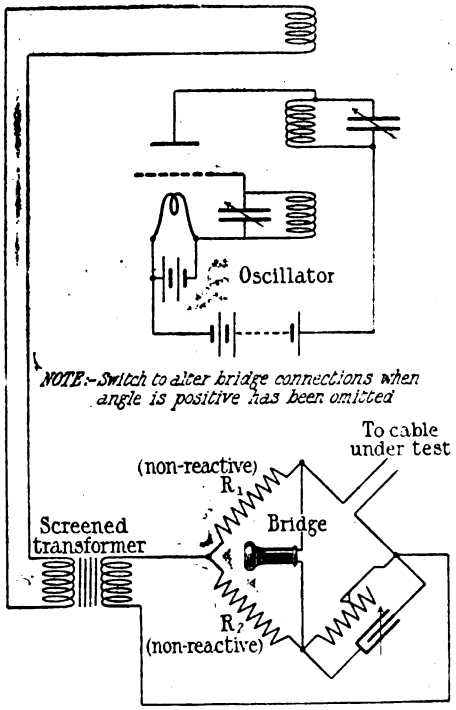


FIG. 7.—SIMPLIFIED DIAGRAM OF BRIDGE AND OSCILLATOR FOR IMPEDANCE MEASUREMENTS.

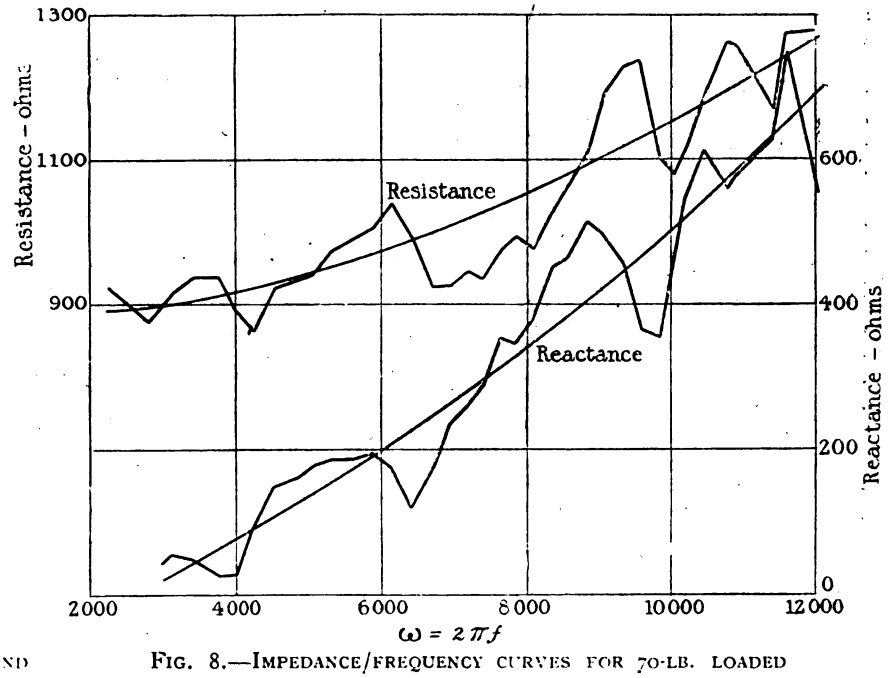
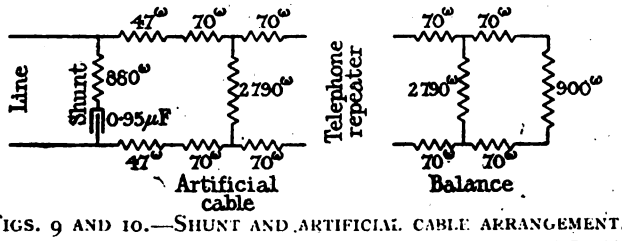


FIG. 8.—IMPEDANCE/FREQUENCY CURVES FOR 70-LB. LOADED CABLE CIRCUIT.

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loading increasing appreciably with frequency. The irregularities in the curves are due to various causes, such as unequal spacing of loading coils and variations between the inductances of the coils along the circuit. This cable



FIGS. 9 AND 10.—SHUNT AND ARTIFICIAL CABLE ARRANGEMENT, AND BALANCE ASSOCIATED WITH TELEPHONE REPEATER ON 70-LB. LOADED CABLE.

was not designed for repeater working, and in more recent cables special care has been taken to keep the inductance of the loading coils within narrower limits and to maintain accurate spacing. It may be mentioned here that an improved type of loading coil has been introduced by the Western Electric Company, which it is expected will be much less liable to vary in inductance with time, and the effective resistance of which varies much less with frequency.

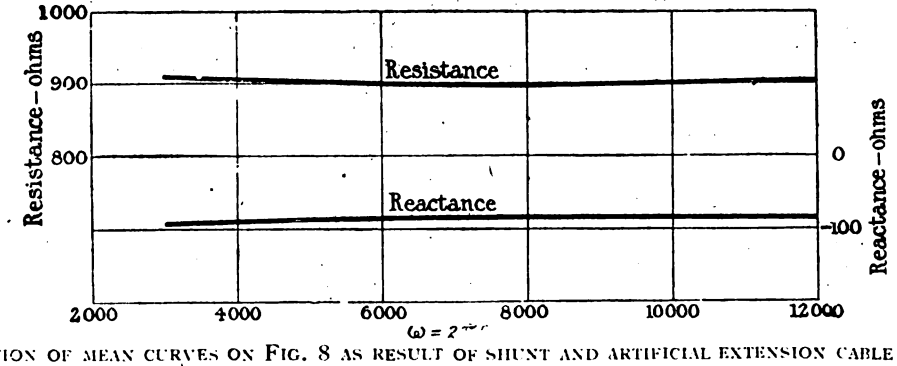


FIG 11.—MODIFICATION OF MEAN CURVES ON FIG. 8 AS RESULT OF SHUNT AND ARTIFICIAL EXTENSION CABLE SHOWN IN FIG. 9.

One method of treating the cable of which the impedance curves have been illustrated is shown in Fig. 9. A condenser in series with a resistance is placed as a shunt across the line, and this produces a modification in the mean curves, as shown in Fig. 11. It will be seen that they are practically horizontal. As the cable in this case is electrically short, an artificial cable is used to extend it, as shown in Fig. 10, and the balance used is shown in the same figure.

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

CONTINUOUS CURRENT ARMATURE WINDING. By F. M. Denton (Pitman, 2s. 6d. net).—This is one of the Technical Primers of Sir I. Pitman and Sons. It is to be regretted that this little book does not meet the requirements of the modern armature winder. This is due to the fact that the author in his classification of CC armature windings, and explanation of the terms, continually refers to ring windings. Ring armatures are decidedly out of date and are never seen at the present time. On page 16 the author shows by illustrations some of the symbols used "to designate windings." These also are out of date and are never used in modern practice. As a matter of fact, they ceased to exist when they were deleted from the pages of a well-known electrical pocket book about ten years ago. On page 35 there is a serious mistake which is likely to mislead the young student. This is the statement that in a four-pole machine designed to deliver 4,000 amperes, with four paths through the armature, each brush would be called upon to carry 1,000 amperes. This is not so, because two brushes would be positive and two negative, hence the amount of current would be 2,000 amperes per brush. On page 58, under the heading of slip-ring connections, it is stated that slip rings in rotary converters are equalising rings. It is true that the tappings of rotary converters must be taken at equidistant points, but they are not equalising rings by any means. Throughout the work the author refers to cell diagrams for various types of windings. These diagrams may be rather novel but they cannot be said to be very instructive. At the end of the book there are several photographs, some of which it would have been much better to have left out. For instance, Fig. 40 shows an armature core slung ready for lifting. No person in charge of the winding department of any electrical engineering company would approve of this method of slinging. The sling is shown pressing against the insulation between the core and the commutator segments. Surely a wooden spreader would convey the idea of the correct method to the student. Fig. 41 illustrates a completely wound armature. This is shown on a table or bench resting on the core and windings. With such treatment it is hardly surprising to find a fault in such a winding when it is placed in commission. A brief reference is made to armature bands, but there is not a word to point out the importance of this subject, or to give the student an idea of the method of fitting them. Fig. 38 illustrates a winder at work with wooden mallet and podger, but there is no information in the book about the essential methods of testing the armature after it has been knocked about a little. It appears to the reviewer that if the points mentioned above are considered in the next edition, it is possible that the book may be appreciated by students of technical schools who desire to know something about the elementary principles of continuous current armature winding.

Receiving Order.—A receiving order has been made, on the petition of a creditor, in the estate of W. A. Davies, lately carrying on business as an electrician at 14, Basinghall St., Leeds, and residing at 14, Knotting Grove, Armley.

Cricket.—On Saturday last Pope Electric Lamp C.C. opened their season with a game against Osram 2nd XI. at Wood Lane, and won by 54 runs. For Pope's, F. Bryant was successful with both bat and ball, scoring 70 and taking 3 wickets for 41 runs, while Mr. Kenneth Pope got 28 runs and took 3 wickets for 33 runs, and Chelsom took 2 wickets for 15 runs.

Engineering Conference, 1921.—Arrangements have been made to continue this year the series of Conferences which were interrupted by the re-building of the premises of the Institution of Civil Engineers, and the war. The Conference will be held on Wednesday, Thursday and Friday, the 29th and 30th June and July 1—the mornings of those days being given to discussions upon selected topics, and the afternoons to visits to engineering works. The complete Programme, including the list of visits to works, will, it is hoped, be ready for issue early in June, and will contain particulars to enable members to decide upon the visits they may wish to attend.

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Various Items.

New Cinemas at Bolton.—Bolton Watch Committee have approved of licences being granted to Mr. F. S. Hampson for a cinema at the corner of Deane Road and Quebec Street, and another in St. Helens Road; and to Mr. Peter F. Jackson for a cinema at the corner of Bury Road and Ainsworth Lane, Tonge.

Blackpool.—The electrical engineer states in his annual report that the withdrawal of restrictions on the purchase of materials for mains and service extensions has resulted in an abnormal number of applications for an electricity supply. The department has, for the first time, been compelled to institute a waiting list of consumers.

A Gas and Electricity Coal Pool.—At Oswaldtwistle, near Blackburn, there is the curious position of the gasworks being dependent upon electricity as the motive power. The manager has therefore allotted 50 tons of coal to Accrington Electricity Works, realising that if current is cut off the manufacture of gas will be seriously affected.

The Industrial League and Council.—The election of the Right Hon. J. H. Whitley, M.P., as Speaker of the House of Commons has caused him to have to resign the Joint Presidency of the Industrial League and Council, which he has held for so long in conjunction with the Right Hon. G. H. Roberts, M.P., and Viscount Burnham, C.H., has graciously consented to become Joint President in his place.

Electricity Supply at Accrington.—Recently Accrington Corporation, acting on the advice of the Electricity Commission, approached Blackburn for a bulk supply from their new station in preference to extending the generating station at Accrington. The Town Clerk now reports that no offers or terms have come to hand and he has been instructed to write the Electricity Commission accordingly. Blackburn's position is that the matter should not be pressed until the new station at Whitebirk is completed.

Electric Traffic Indicator.—The British Road Traffic, Ltd. (54, George Street, Portman Square, W.1), is about to place on the market an electro-magnetic device for motor vehicles whereby the driver can warn either front or rear approaching traffic of his next movements. An arrow on a white opal dial, fitted to the vehicle, gives the necessary indication and is visible at a distance of 50 to 100 yards by night or by day. It is operated from the steering column or other convenient position. A working model has been tested and found to give satisfaction under all road and weather conditions, and is claimed to be absolutely fool-proof. The model may be inspected at the address given above.

A Masonic Presentation.—Prominent Freemasons entertained at luncheon on Thursday, the 5th inst., at the Cafe Monico, W., Mr. Charles F. Quicke, Past-Grand Superintendent of Works and a Past-Grand Warden of La Grande Loge Nationale de France. Mr. Charles E. Keyser, Past-Grand Warden of England, presided and made a presentation to Mr. Quicke of a gold cigarette case enclosing a cheque subscribed by those present, and a silver epergne for Mrs. Quicke. Mr. Quicke has been an active supporter and worker of the Royal Masonic Institution for Boys, the Royal Masonic Benevolent Institution, and the Masonic Nursing Home. Professionally he is a well-known London electrical engineer, and as such is an honorary member of both the Kelvin Lodge and the Kelvin Chapter, of the latter of which he was one of the consecrating officers.

Swansea.—At a meeting of the Swansea Electricity Committee the engineer (Mr. W. J. W. Burr) stated that a firm who were offering German made meters had stocked them in London and the 50 per cent. tax did not apply. In any case where they accepted orders the price quoted would be inclusive of all charges, they being themselves responsible for the payment of the 50 per cent. or any other tax by the Customs. Mr. R. G. Clarry moved that the engineer buys English made meters, as none of the money, if they purchased German make, would go to the British Government. In replying to another member the engineer said he was satisfied that the choice was between purely English and purely German meters. The motion was carried. It is understood that the difference in price was 16s.——Last month 33 fresh applications for power were received by the Swansea Electrical Committee, and an extension of a main cable in Oakwood Road would cost £130 and would bring in an additional revenue of £35 per annum.——Mr. W. J. W. Burr stated that the supply of power would last for several weeks. The load had been reduced, through many works being idle, but load factor and poorer quality of coal had prevented a reduced coal consumption to the same degree.

Great Northern Hospital.—Princess Alice, Countess of Athlone, has kindly consented to open the Crewe House Bazaar (in aid of this Hospital) on Thursday, June 2, at 3 p.m. Gifts towards furnishing the stalls will be heartily welcomed.

Congratulations.—At the Annual Meeting of the British International Association of Journalists, held on April 22, 1921, Mr. Leon Gaster, F.I.J., the Hon. Secretary of the Illuminating Engineering Society and Editor of *The Illuminating Engineer*, was unanimously elected the Honorary General Secretary of the Association.

Whitley Council for the Railways.—By the agreement just signed by the Railway Companies and the three great Railway Trade Unions whereby, on decontrol, joint Councils of officials and employees are to be formed to deal with administrative and labour questions, on the principles of the Whitley Report, we see an important indication of a return to sanity in the conduct of British industry. The step taken is a feather in the cap of the Industrial League and Council, which is continually advocating the creation of a spirit of co-operation and conciliation in industrial administration. May its influence be felt in other labour fields.

Cardiff.—A curious position has been created relative to the supply of electricity in the areas now governed by the Llandaff and Dinas Powis Councils. These authorities a few years ago made an agreement for supply of electricity from the South Wales E.P.D. Co. in bulk to certain areas. These areas will now, under the extension scheme, be absorbed by the City of Cardiff, who have a fully equipped electrical installation capable of supplying a much larger area than will be taken under their Greater Cardiff scheme. The City municipal clerk points out that there is a contract extending for 30 years existing between the Llandaff Council and the S.W.P.D. Co., and the Company had written making representations that that contract should be allowed to remain undisturbed. It is suggested that the contract should be purchased by the city on reasonable terms, but the matter has been relegated to the Parliamentary Sub-Committee.

Service Notes.—Captain A. Reed, Tynemouth Electrical Engineers, who has just been appointed adjutant of that corps, was its quartermaster up till recently. He received his quartermaster's appointment in September, 1915, and reached the rank of captain during the war. The adjutancy had been vacant for some months, during which Captain Reed acted as adjutant, his appointment in the latter capacity now dating back to January last. Wireless Telegraphist A. Dean, serving ashore, has been promoted commissioned telegraphist from the 12th ult.; Wireless Telegraphist H. Johnstone, serving with the "Vivid" at Devonport, has been promoted commissioned telegraphist from the same date; and Wireless Telegraphist A. H. Warburton, serving on the flotilla mother "Maidstone" has been similarly promoted. All three received their warrants in 1911. Warrant Telegraphist A. E. Wither has been appointed to the destroyer "Shakespeare" for wireless telegraphy duty with the Sixth Destroyer Flotilla, from May 1.

Leeds.—Following upon drastic "cuts" in the electricity supply, consequent upon the scarcity of coal for the boilers, the Electricity Committee took immediate steps to save the situation. A deputation visited Hull and inspected the oil fuel burners installed by the authorities there. The impression gained was so favourable that steps were at once taken to convert the boilers at the Leeds works in the same way. This has been done, and the immediate effect was that practically the whole tramcar service was recommenced on Monday. The effect of the reduction of the tram service was noticeable on the first day, when the takings dropped £1,000 as compared with the corresponding day of the previous week. It is hoped to fully recommence the full service very shortly. In the meantime the supply of electricity for power purposes is still limited to three days a week. It is claimed that by the use of oil fuel economy will be attained, whilst at the same time, when coal is available at an economic price, the boilers can be reconverted in a few minutes.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
MAY 20, 1921.

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MAGNETOS FOR IGNITION PURPOSES IN INTERNAL COMBUSTION ENGINES.

In a paper on the above subject, read before the Inst.E.E., on April 14, by Mr. E. A. Watson, the conditions which have to be fulfilled by ignition magnetos in internal combustion engines were first considered.

These conditions are extremes of speed, high and low, voltage required, and adverse circuit conditions tending to reduce the voltage.

The magneto to be satisfactory must give a spark at sufficiently low speed to enable the engine to be started readily, and must give regular operation at high speeds under adverse conditions. The former condition is the least easy to obtain. The speed at starting depends on the class of service for which the magneto is intended, and data is given for various types of motor vehicles. The effect of adverse conditions, such as leaky plugs and wiring, and the capacity of the plug are dealt with. A method of estimating the capability of a magneto for dealing with leaky circuits is described, and characteristic curves given by various machines are illustrated.

The paper next deals with the principles of operation of a magneto. The cycle of operations accompanying each spark is considered in successive steps. These may be divided into :—(1) Storage of energy in the magnetic field; (2) the collapse of this field, and the transference of the energy to the secondary circuit.

The best method of treating a magneto is to consider it as a high-tension alternator in which a special artifice is employed to obtain a rapid movement of the flux relative to the armature winding at one particular instant, while keeping the speed of rotation of the armature down to a low figure. The same artifice also serves to make the rate of movement of the flux to a certain extent independent of the speed at which the armature is revolving. This artifice consists in the employment of a winding, generally known as the primary, which is short-circuited during a portion of the revolution. Currents are induced in this short-circuited winding which tend to prevent any change in the flux linking it, and which consequently produce distortion of the magnetic field. At a definite moment the primary circuit is interrupted by the contact breaker, and as the distorting current then ceases, the magnetic flux rapidly returns to its original position. In so doing it cuts both the primary and secondary windings, the latter of which is closely linked with the former by being wound upon the same core. The rate of movement of the flux back to its original position can be made very rapid, provided that the circuit is well laminated, and in consequence a high voltage is induced in the windings which it cuts. In a few magnetos the primary and secondary windings are not coupled together by being wound upon the same core but are coupled electrically, there being in this case three windings, one on the armature of the magneto, of relatively few turns of thick wire, a similar one wound on a separate small transformer incorporated with the machine, and a high-tension winding wound on this transformer and linked with it. The impulse generated in the armature winding is in this case transformed up by the transformer to the voltage necessary to produce a spark.

In order to secure a sparkless break, a condenser is connected across the points of the contact breaker, the precise function of the condenser being considered later. The cycle of operations may be divided into two principal parts :—(*a*) A period during which work is done upon the magnetic field in distorting it, and energy is stored therein; (*b*) a period during which this stored energy is returned to the circuit as a spark.

In attempting to predetermine the performance of a magneto it is first necessary to inquire into the relation between the properties of a permanent magnet and the energy which can be stored in the field furnished by it. There are several possible arrangements of the magnetic circuit, all of which are in common use. The most notable at the present time are (1) the ordinary revolving **H** armature, (2) the sleeve type, (3) the polar inductor type.

In (1). an **H** armature carrying primary and secondary windings rotates between the poles of a permanent magnet. In (2) a revolving sleeve rotates co-axially with a stationary **H** armature, producing a reversal of the flux as the armature rotates. Class (3) comprises a variety of machines, in all of which a revolving inductor controls the passage of flux through a fixed armature circuit. The first class necessarily gives one complete flux reversal to each revolution, the second gives two complete reversals, while the third gives any number which may be desired, within certain limits.

The majority of magnetos belong to the first class, although some of the very earliest ones were in the second, and a large number of magnetos of this type by the Bosch, B.T.H. and other firms have been put into service. The third class is chiefly exemplified by the American Dixie magneto, followed later by the B.T.H. type AV machine, while other examples are found in the American Berkshire magneto and in several new forms of aeroplane magnetos which have recently been developed by the B.T.H. and Thomson-Bennett.

Although these machines differ greatly in construction, the principle is the same in all, and is found in its simplest form in the ordinary **H** armature machine of class (1). The relation between the properties and the dimensions of the magnets, and the energy which can be stored in the magnetic field, is considered in detail, attention being drawn to the importance of the shape of the *BH* loop and its effect upon the energy which can be stored. It is shown that the most important property of the magnet is the maximum value of *BH*. Magnetic data for various steels are then given, and also the magnetic content which is usual for magnets on magnetos intended for various classes of service. The principles governing the proportions of the magnet, namely length and cross-section, are considered in detail. The effect of the armature resistance is then considered, and it is shown that for the best results it is important to keep the resistance of the primary winding as low as possible, and secure the best possible linkage between the primary winding and the working flux.

The effect of the condenser as a spark suppressor is next considered, and a brief account is given of Prof. Taylor Jones's theoretical investigation of the effect of condenser capacity, it first being pointed out that sparking should be independent of the material of which the contact points are made, whereas it is well known that only certain metals, such as platinum and iridio-platinum, which do not form oxides when heated, can be employed, and that even with these metals the sparking is largely affected by the condi-

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tion of the points themselves, and can be greatly increased by the presence of small traces of dirt and impurities.

The problem, therefore, is not so much the suppression of true sparking as that of the suppression of arcing, and it is probable that the rate of movement of the points once they commence to separate is of secondary importance, the function of the condenser being to prevent local heating of the points which would tend to vaporise the metal and make conditions favourable for the production of an arc. Such local heating would be accompanied by a large value of the *IR* drop, and this can be prevented by a condenser of suitable capacity. It could also be reduced by keeping *I* as small as possible, i.e., by using a large number of turns in the primary winding, and, as a matter of experience, this is actually the case, the sparking at the points being diminished with an increase in the number of primary turns beyond the value at present customary. If the number of turns be made sufficiently large, true sparking sets in of an appearance quite different from that of the arcing usually known by this name. At present, primary windings in which the number of turns is sufficient to give these conditions are not employed, as the voltages to which the insulation of the condenser and contact breaker would be subjected are considerable.

Generally speaking, it may be said that the conditions existing at the moment of break are but little understood and that a carefully conducted research into them would be well worth while, especially if it should lead to the successful employment of some other material in the place of platinum, the price of which is continually advancing with apparently small hope of increased supplies.

Considering the condenser merely as a spark suppressor, it is clear that the smaller the capacity which can be employed the higher will be the secondary voltage for a given primary winding and a given flux-change, the voltage increasing with a diminution of condenser capacity down to that value at which sparking commences. At this point the interruption of the primary current is no longer perfect, energy is dissipated at the break and irregular functioning of the machine occurs. Curves are given showing the way in which the secondary voltage of a given machine changes with variation in condenser capacity. As might be expected, the minimum capacity which can be employed is smaller the less the energy which has to be handled. Another curve shows the intensity of sparking at the points in terms of the condenser capacity. In this case the sparking falls steadily as the condenser capacity is increased. It is found that the capacity necessary to render a machine quite sparkless is considerably greater than that which gives the highest voltage for a given low speed, and hence we should expect the capacity fitted to be a compromise between that necessary to give absolute suppression of sparking and that which gives the best low-speed performance. The capacity fitted may depend upon the duty required from the machine; for example, a magneto which never required to run at very high speeds, but in which good low-speed performance was essential, might have a smaller condenser than one which had to operate at very high speeds.

Professor Taylor Jones's treatment of the magneto shows that the voltage at the secondary terminals when the machine is running on open circuit, i.e., without any spark occurring, will be given by a wave composed of two superimposed oscillations, a long-period one and a shorter-period one. The magnitude and frequency of these will depend upon the inductances and capacities associated with the primary and secondary circuits, and upon the coupling between them. As the damping in a magneto is always very large the first half-wave only is of importance, and the best results will be obtained when the maximum of the low- and high-frequency oscillations coincide. Consequently, the condenser capacity should be chosen to conform as nearly as possible to this condition, provided of course that such a capacity is not likely to produce sparking at the points.

In nearly all magnetos the primary and secondary windings are very intimately linked together, the insulation between them being, from space considerations, made a minimum. Consequently, the coupling is normally very close, and the corresponding value of primary capacity which will give the maximum secondary voltage is in general much less than that required to suppress sparking. Moreover, the theory shows that with such close coupling the optimum values of primary capacity are not clearly marked, and that the choosing of such a capacity can only correspond to an improvement of a few per cent. In order to gain any real advantage from the correct choice of primary capacity, it is necessary to make the coupling much looser, and theoretically in this case a considerable improvement in secondary voltage can be obtained by choosing the optimum primary capacity. In addition, this capacity becomes more of the value which is required in order to suppress sparking.

There are, however, two objections to such a course. In the first place, the difficulty of providing for the decreased coupling without increasing the size of the machine or decreasing its magnetic efficiency, and in the second, the fact that the secondary voltage will depend very largely upon the secondary capacity and its correct relation to the other constants of the machine. Consequently, a slight change in the length of high-tension leads or in the type or dimensions of the sparking plugs fitted would affect the performance of the magneto and would need a corresponding adjustment of the primary capacity to be made. Again, the damping plays such an important part in the performance of all magnetos, even with the best laminated magnetic circuits, that the predictions based on any theory ignoring damping cannot be fulfilled, and actual measurements made on existing machines scarcely seem to indicate that, at present at all events, it is possible to make any very practical application of Professor Jones's work. Possibly future changes in design and methods of construction will permit of better use being made of his very complete mathematical analysis, and enable machines to be constructed in accordance with the principles therein laid down.

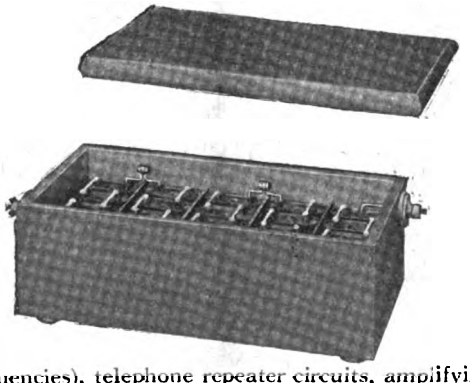
The author then pursues the subject further and deals with magnets for existing multi-cylinder machines showing that complete extinction of the spark is controlled by :— (1) The time available, i.e., the speed of rotation and length of cam. (2) The resistance of the spark circuit. (3) The inductance of the secondary winding, i.e., the stiffness of the magnetic field and the number of secondary turns.

Experimental results are given showing the way in which incomplete spark extinction reacts upon the performance of the machine.

Brief reference is then made to some of the mechanical points involved in the design and construction of magnetos.

"HART" H.-T. ACCUMULATORS.

The illustration shows a "Hart" High-Tension Accumulator, type "P.L.," which has been specially designed and manufactured by the Hart Accumulator Co., Ltd. (Stratford, E.15), for thermionic valve amplifiers for wireless (high and



low frequencies), telephone repeater circuits, amplifying telephones, cable testing, as well as for laboratory and works testing where small currents of high voltage are

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required. These accumulators are made in 50-volt units, measuring 14 in. by 7½ in. by 5 in., and have a capacity of 1.2 amp. hours at the 10-hour rate (they may be recharged in eight hours or less). No celluloid is used in their construction, the plates being fitted in an ebonite box of special design to ensure high insulation resistance. Each cell can be examined at any time by removal of the lid of the box, which is of waxed teak. Outside terminals and insulating feet are provided. Batteries of any voltage, in multiples of 50 volts, can be supplied from stock, or batteries of any intermediate voltage can be made to order. They are used by the G.P.O. and various telegraph companies.

NOTES ON BALANCING THE D.C. SUPPLY FROM ROTARY CONVERTER SUB-STATIONS.

The method adopted in modern practice for balancing the direct-current, three-wire supply from a rotary converter sub-station is a modification of the three-wire static balancer with the addition of a booster connected in the middle wire, and the general theory of its operation may be considered as follows :—

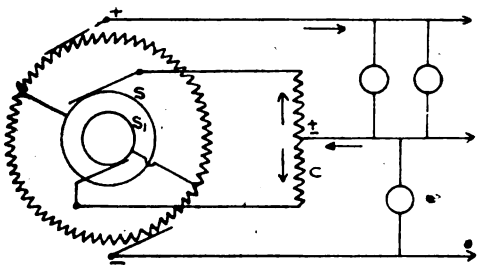


FIG. 1.

Referring to Fig. 1, which represents the diagram of connections for a single-phase system (two-pole armature winding), a choking coil C having a closed magnetic circuit is connected across slip-rings S S1, to which are connected tappings taken from diametrically opposite points in the armature winding, the middle wire of the D.C. system being connected to the centre point of the balancing coil C. As the slip-ring tappings are connected symmetrically with respect to the armature winding the P.D. at the centre point of the balancing coil will be half the value of the P.D. between the positive and negative brushes.

The neutral of a three-wire system may, therefore, be connected to the centre point of this coil instead of using the ordinary type of balancing arrangement.

When the load on the system is balanced there will only be a magnetising current flowing through the balancing coil, alternating as the relative potential between the tappings changes from a positive to a negative value.

When the load becomes unbalanced, due, for instance, to a larger current on the positive than on the negative side, the excess current will return by the neutral wire and divide in the balancing coil, reaching the armature through the slip-rings. The excess current always returns to the brush on the heavily-loaded side of the system, and the relative direction of the currents in the various circuits for one position of the armature is indicated by the arrows.

When this system of balancing is applied to the D.C. side of a polyphase rotary converter it will be evident that the out-of-balance current will be more evenly distributed through the armature winding due to the increased number of tappings, this current being fed into the armature at six points in the case of a six-phase converter, instead of two points for a two-pole machine. The general theory of the balancing effect with six tappings is similar to that already described,

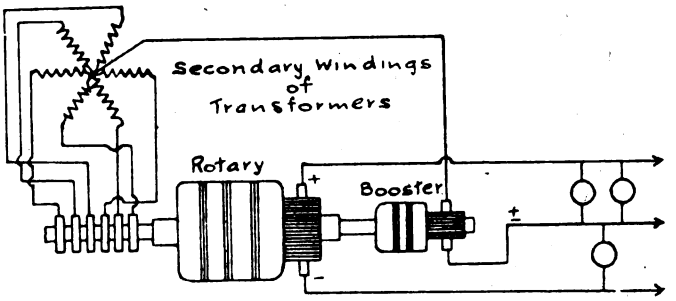


FIG. 2.

and the diagram in Fig. 2 represents the connections for a six-phase converter. A booster is connected in series with the middle wire for the purpose of compensating for the resistance drop in the transformers and armature of the converter due to the out-of-balance current. With this arrangement the windings of the transformers also act as balancing coils, each phase carrying one-sixth of the total out-of-balance current in addition to the alternating current supplied to the converter.

The advantages of this system of balancing over the ordinary balancer set are as follows :—

(a) It is unnecessary to run a series of small machines, upon the satisfactory working of which the whole D.C. supply is dependent.

(b) Increased over-all efficiency of the distributing system.

On the other hand, this system has the following disadvantages :—

(a) The inability of the transformers and converter armature to carry a large out-of-balance current for long periods when supplying the full power load, due to the tendency for overheating.

(b) It is not advisable to run a converter on one side only of the three-wire system, as the maximum out-of-balance current it is possible to deal with is limited by the regulation and heating of the transformers and converter armature.

In spite of these disadvantages, however, the application of this balancing arrangement in connection with direct-current supply from rotary converter sub-stations has greatly increased during recent years.

Golf Rules.—Last September the Royal and Ancient Golf Club of St. Andrews made certain important changes in the rules of the game, and the Royal Insurance Co., Ltd., are issuing to their friends a copy of the latest rules This contains a comprehensive index and in addition an inset showing the differences between the old rules and the new, together with a few facts relating to the rubber core ball and, having regard to the controversy which has centred around the decision to limit the size and weight of the ball, the information we think will be of interest to many of our readers. The Official Rules which have just been issued from St. Andrews operate as from May 1. So far as the stock will permit, the Royal Insurance Co. will be happy to forward a copy to any of our readers who care to apply to the Company's Head Office, North John Street, Liverpool; Lombard Street, London, E.C.; or any of its Branches.

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TECHNICAL ASPECTS OF SUPER-POWER SCHEMES.

There can be no doubt that three-phase alternating current will be used in all installations for the long distance transmission of electrical energy in bulk in connection with super-power schemes. High-tension direct current offers the advantage that the transmission is not affected by self-induction or capacity in the line. Also, direct current has the advantage that the effective voltage is also the maximum voltage, which is not the case in an alternating current circuit. It follows that for the same effective voltage the insulators on an alternating current line have to be designed for a much higher voltage than those for a direct current line. Against these advantages of direct current there must, however, be set the much greater advantage that alternating current can be raised or lowered in voltage by static transformers which are simple, reliable and efficient, whereas extra high voltage direct current is rather an unmanageable quantity involving series-connected rotating machines for its production and voltage transformation.

The difficulties arising from self-induction and capacity where the long-distance transmission of alternating current energy is concerned may be overcome by the judicious employment of over-excited synchronous machines at the load end of the line. By this means the voltage drop can be compensated entirely, and a high power factor can be maintained throughout the system. Also, the total power losses in transmission can be kept within entirely acceptable limits. The problem as a whole is considerably simplified by the fact that it is not a case of transmitting a vast amount of power from one end of a country to the other, but rather of tying together a number of power-distributing networks, the tie lines carrying only the surplus or deficiency of power which cannot be used or provided, as the case may be, in the individual industrial areas concerned. Signs are not wanting that the super-power schemes or national electricity networks of the Continent will provide for the export of surplus electrical energy to adjoining countries. Though this proposal sounds somewhat startling, it is identical in principle and much more efficient in practice than the export of coal.

An interesting problem is to decide what line voltage should be used for transmission networks of the type under consideration. The problem is a complex one, involving both financial and technical considerations. Broadly speaking, the cost of the transmission line itself becomes less and less, the higher the line voltage; but, on the other hand, extra expense is involved in the insulation of the line and of the transformers. An important consideration is that the amount of power to be broken by the main switchgear is the same at all voltages, whereas the difficulty of interrupting a high-power circuit increases with the working voltage. A line voltage of 250,000 volts is proposed for trunk transmission lines in America, and there is no reason to doubt that such lines could be operated quite satisfactorily with equipment which can now be built by manufacturers under commercial guarantees.

A bulk transmission network is under consideration in Germany, and its technical and economic features have been considerably discussed in the German technical Press. It has been estimated that 220,000 volts is the most desirable line voltage from the economic standpoint, but 110,000 volts is the highest line voltage yet employed in Germany, and there seems to be a feeling that this voltage would be sufficient for the national network, whilst avoiding a good many difficulties and risks associated with a 220,000-volt system. Working at 155,000 volts, the total length of line required would be reduced by about 50 per cent., and at 220,000 volts the total length of conductors required for the power transmission under consideration would be only about 25 per cent. of that required at 110,000 volts, but it must be remembered that the use of a single line instead of a quadruple line for the transmission of the same amount of power would involve a corresponding increase in the risk of interrupted supply.

The principal causes of service breakdowns on overhead transmission systems are voltage surges, breakdowns to earth, and short circuits between phases. Any one of these troubles is very prone to set up either or both of the others. Similarly, protection against any one of these causes of trouble is, to a great extent, effective in protecting against the other causes. Thus a satisfactory method of dealing with breakdowns to earth gives a large measure of protection against voltage surges, and this in turn reduces the risks of short circuit. The adequate protection of A.C. networks is a wide and complex subject demanding close study of load and circuit conditions, but it may now be claimed that selective protective apparatus is available which will confine interruption of service to the section immediately concerned in any A.C. system. Also, such apparatus will discriminate between real and transient troubles, and between various causes of trouble, with almost human intelligence, and far more than human reliability and speed of action.

INTERNATIONAL CREDITS.

A booklet explaining impartially the ter Meulen scheme for International credits, as approved by the League of Nations, has now been published by Harrison and Sons, 44-7, St. Martin's Lane, W.C.2, at the price of 6d. post free. The scheme is simply an attempt to assist traders in impoverished countries to import on credit so as to re-establish industry and revive trade. It is intended that the governments of such countries pledge a proportion of their national assets as security for credit granted to traders. The International Financial Commission, which is to be formed by the League, will determine the value of the assets in gold and authorise the issue up to that amount of Government bonds in any currency for loan to traders, who will use them as security in order to obtain credit from traders in other countries. The adoption of the scheme is in no way advocated in cases where traders are able to do business, by the ordinary methods, without it. On the other hand its value should be appreciated when this is not possible, and exporters in this country can best assist in getting the scheme inaugurated by impressing on foreign importers who cannot obtain the necessary credit without providing some special security that this scheme provides the best chance of obtaining financial facilities on reasonable terms. By stimulating a public demand in impoverished countries for the bonds, the various governments will be the more ready to apply for their issue.

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PAGES FROM OUR DESIGNER'S NOTEBOOK

WESTON ELECTRICAL INSTRUMENT CO LTD

THE WESTON TRUSSED POINTER.

For Alternating Current Instruments.

The object of the above construction is to ensure complete freedom from resonant vibration throughout any commercial range of frequency.

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POINTER AND BALANCE CROSS OF MODEL 167 WESTON WATTMETER.

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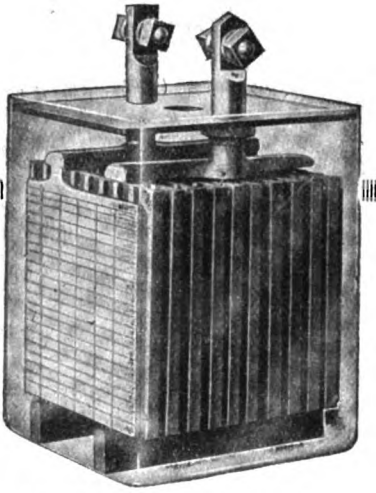
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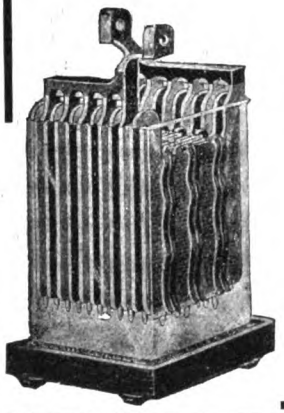
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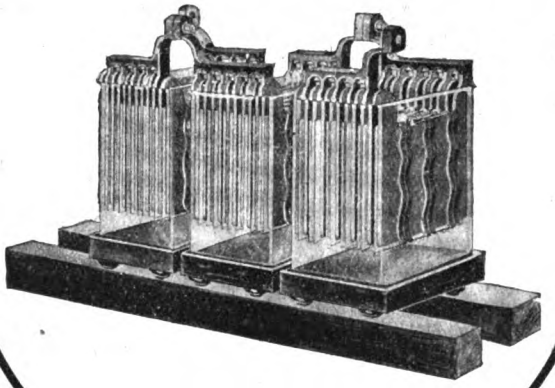
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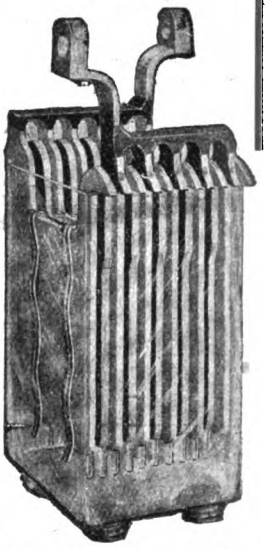
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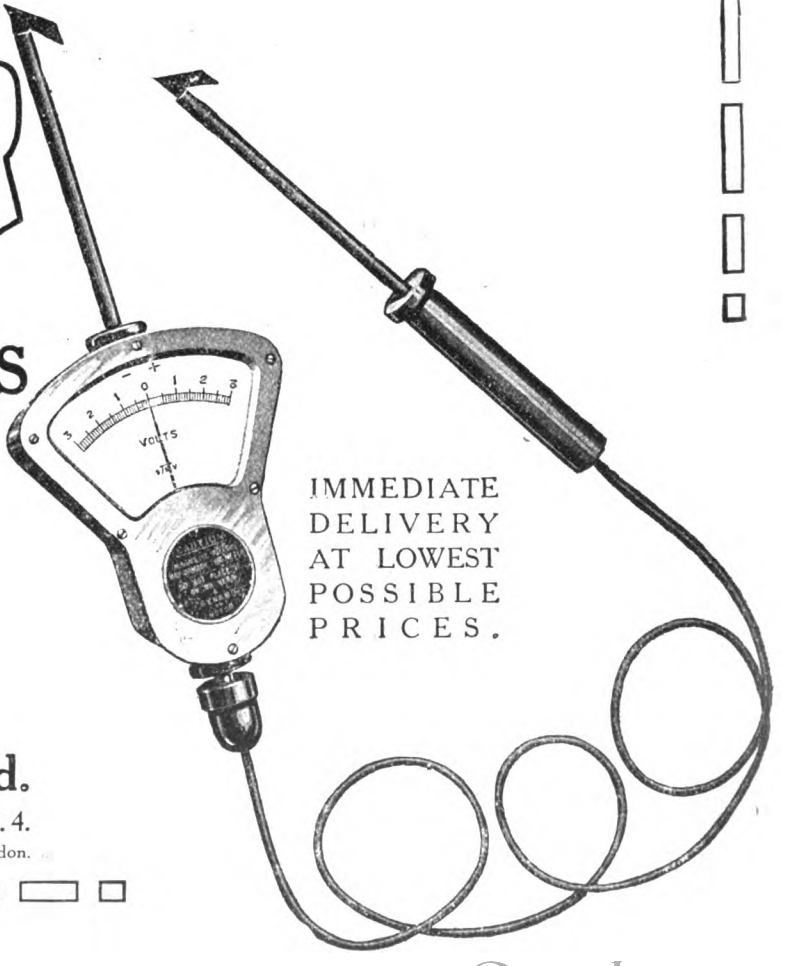
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application.

Subscription.—17s. 6d. a year, 8s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

The Profiteers.

Among other things, this coal strike is bringing grist to the mill of the out-croppers, many of them miners on strike, who are reaping a rich harvest by collecting any old black stuff which looks like coal, concealing it carefully in obvious coal bags, and retailing it to any fool householder who is weak enough to be diddled into buying what he can dig up for himself on any rubbish heap. I know a man who purchased a hundredweight of this alleged fuel, and, after consuming about a quart of petrol in a high-power blow lamp, managed to get a grate full to a dull red heat. This so excited his better half that she promptly applied potato peelings to keep the home fires burning and promptly extinguished whatever combustion was in progress.

Strike or no strike, it is the giddy old householder, you and I, dear reader, who pays in the long run. The latest to join the ranks of disaffection are the "sparks," and for the umpteenth time our electricity supplies are threatened. This is a happy land and no mistake; with trade and industry practically at a standstill, and our manufactures too costly for anybody to buy, the industrial population must needs make matters worse by refusing to accept any share in the responsibility for such inflated costs of production. All the jam and none of the powder, as usual. There is one very obvious upshot of the whole business. Won't work will have no work to go to in the long run, and that will be an end to it.

An Edison Comedy.

Mr. Thomas A. Edison has been pulling the leg of an American reporter, and I have no doubt he is laughing up his sleeve over a paragraph which is going the rounds in consequence. It seems that an examination was set to test the intelligence of some 300 applicants for jobs in the Edison factory. There were 141 general knowledge questions to be answered, such as "Who wrote 'Home Sweet Home'?" "What is the greatest depth of the Atlantic?" "What country consumed most tea prior to the war?" and a few other specimens of a like kind. As a result, 270 candidates failed to pass the test, which was subsequently denounced as "silly." A New York paper promptly sent a reporter to interview Mr. Edison at his private house. The reporter pressed Mr. Edison's front door bell and it refused to work. The paper makes much capital out of the incident, but the cream of the joke is that Mr. Edison in all probability knows why the bell didn't work—because he had anticipated the visit and disconnected the bell.

A Tribute.

I am a firm believer in giving due publicity to a good article, and especially so when the subject under review is electrical in character. Hence the following eulogy: Some eight years ago, before the war had temporarily dulled our close interest in things electrical, I attended a Colliery Exhibition held in Manchester. On behalf of this paper I reported on most of the interesting electrical exhibits, and among others, on the Alklum accumulator, which was being shown in connection with the miners' and other portable electric lamps, as well as a portable battery for various purposes. Being interested in the performance of these alkaline cells I was favoured with a four-cell battery for testing purposes.

Immediately on receipt of the battery I put it into constant and arduous service, subjecting it to all sorts of ill-treatment which would have speedily put an end to many ordinary lead-acid batteries. It was over-discharged, left uncharged for lengthy periods, short-circuited, charged in the reverse direction, and generally maltreated. Used in connection with motor-car lighting and ignition it was subsequently subjected to considerable road vibration, and during its life it has travelled many miles on the carrier of a motor cycle, where it was not altogether immune from vibration of the most intense variety. In spite of this mishandling, the Alklum battery came up smiling every time, and gave its full capacity to ten ampere hours until a short while ago, when, due to rust and neglect, the outer steel cases corroded away and the electrolyte leaked out.

I thought this the end, and prepared to relegate an old friend to the scrap heap with the reflection that, after all, eight years' constant hard service was jolly good for a portable battery. As luck would have it, business brought me in contact with Messrs. Batteries, Ltd., Redditch, makers of the NI-FE alkaline accumulators, and I then learned that my old original battery had been made in Sweden, under the Jungner patents, and that the firm above mentioned were now manufacturing identically the same battery in this country. I congratulated them upon the behaviour of their product, and related its history, adding that I was about to scrap the remains. I then learned to my astonishment that the electrodes were probably good for another span of life, being to all practical intents and purposes indestructible.

I accordingly handed over the corpse for treatment, and was advised that on removing the electrodes from the old rusty cases and testing them for capacity, they were found to still retain their original ten ampere hours. I have just received the battery from the makers, fitted with new containing cases and a new crate. It looks as good as ever, and I look forward to another lengthy span of useful service free from accumulator troubles. In the circumstances I can unhesitatingly recommend these cells to the notice of any reader requiring a reliable hard service battery,

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particularly for locations or conditions where the battery will be subject to such occasional neglect as would ruin an ordinary lead-acid accumulator.

Diagrams—Their Use and Abuse.

There is nothing like a clear and comprehensive diagram of connections for explaining the why and wherefore of most electrical installations. A good diagram will do more than reams of descriptive matter or hand books on operation and maintenance. It tells the intelligent electrician all he wants to know about the wiring and electrical gear under his control. It enables him to trace out circuits to their logical conclusion and prove or disprove his own theories of how a certain gadget does it work. I strongly recommend all manufacturers of electrical plant and apparatus to concentrate on good wiring diagrams as an essential feature, and see that every customer is supplied with an adequate set.

Just a word of warning, however, there are diagrams and diagrams. There is the tennis net sort of diagram which conveys the impression of umpteen short circuits to the square inch. There is also the Hampton Court Maze diagram in which you follow or attempt to follow a circuit with a pencil point or stylus and end up on the pretty frame with which the draughtsman has surrounded his effort. Then there is the type of diagram which takes you to a point and ends in some hieroglyphic known only to the draughtsman, which may be anything from an earth connection to a disconnection; I hate those diagrams which leave you to assume a lot of things not in the picture; you require a cinematographic brain to fill in the gaps.

Finally, there is the diagram—a masterpiece in the eye of its originator—which unblushingly records *every* circuit, even where there are twenty or more of identically the same character. They usually resemble a fine etching, and no one ever attempts to read them. Keep your diagram as simple as possible, but include all essentials, and, where there are no recognised conventions for the apparatus shown, indicate clearly what is the character of the unknown pieces of apparatus. I have known a voltmeter to be misread as a D.C. generator and an incandescent bulb as a pear switch before now.

ELEKTRON.

Bath.—£30,000 is contemplated being spent on new mains.

Llandovery.—The borough authorities have under consideration the question of laying down generating plant. The matter will come up for consideration at the next monthly meeting.

Worksop.—The Electric Commissioners are to be asked for sanction to a scheme for extensions costing £23,965, including £13,042 for cables. It is proposed to purchase bulk supplies from the Wigan Coal and Iron Co., and to alter the supply from D.C. to A.C. in the area outside the town.

Meetings.—At the last general meeting of the Electrical Trades Benevolent Institution, alterations were made to the rules giving additional powers to the local advisory committees. The necessary confirmatory meeting will be held at the Cable Makers' Association, Sardinia House, Sardinia Street, W.C.2, on Monday, 27th June, at 2.30 p.m.——A Wireless Section meeting of the Inst.E.E., will be held at the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W., on Wednesday, 25th inst., at 6 p.m., when a discussion will be opened by Mr. C. F. Elwell (Member) on "Long Distance Wireless Transmission."

THE ELECTROLYTIC RECOVERY OF ZINC.

Among the papers read at the last meeting of the Faraday Society was one by Mr. S. Field in which he advocated the electrolytic recovery of zinc as an economic proposition in Great Britain. The British spelter industry is at present very depressed and there is room for an enormous increase in the output of zinc. Home ores should, therefore, if possible, be used. Abundant supplies of low grade and complex ores are available, but they are not amenable to distillation though they respond readily to alternative electrolytic treatment, for which processes have been worked out to effect economic recovery. Briefly put, sulphide ores are calcined to oxide and a predetermined proportion of sulphate. The calcine is bleached with acid zinc sulphate liquors (3 per cent. Zn+10.5 per cent. H_2SO_4) from the electrolytic cells. Special treatment avoids gel formation, and admits of high extraction and easy filtration. The lead-silver residues go to the blast furnace, *via* sintering, for the recovery of argentiferous lead.

The zinc sulphate solution is much too impure for efficient deposition. High purification is a *sine qua non* for subsequent economic deposition. The methods worked out are given in some detail and comprise the use of such oxidising agents as air, ozone, lead, and manganese dioxides for the removal of Fe, As, Sb, and Co. Zinc dust in a slightly acidified solution readily removes Cu, Cd and Ni, greater speed of elimination being obtained with the concomitant elimination of Co by the prior addition of about .005 to .01 per cent. Hg as sulphate. Ni and Co constitute two commonly met and insidious impurities. The purified liquors contain not more than 3 to 5 parts Co and .2 part Ni per 1,000,000. The pure neutral solution is acidified down to 3 per cent. Zn + 3 per cent. H_2SO_4 and electrolysed between lead anodes, which in the absence of certain impurities are very permanent, and aluminium cathodes. The liquors attain a desirable maximum temperature of up to 40-45° C. and the cells, arranged in cascade, absorb 3.35 volts and give a current efficiency of 90 per cent. This represents about 3,200 k.w.h. per ton of zinc cathodes. The outflowing liquor is used cyclically for extraction and acidification.

Subsidiary power is amply covered by 800 k.w.h. per ton. Hence 4,000 k.w.h. (=160 k.w. per ton cathode zinc per day) covers all power. This should be raised from low grade fuel at .32d. to .35d. per unit. At .33d., power costs are £5 11s. per ton of cathode zinc. The cathodes are melted and yield ingots assaying not more than .02 per cent. Pb, .02 per cent. Cd, and .01 per cent. Cu and Fe together, with at least 99.95 per cent. zinc. Purification is simplified if only a 99.92 per cent. product is required.

Burnley.—The Electrical Engineer has succeeded in securing coal sufficient to ensure a continuance of the electricity supply for two or three weeks.

Cardiff Experimenting with Oil.—Mr. Morley, New City electrical engineer, is experimenting with oil fuel at the generating station, and it is highly probable that extra sets for oil fuel will be installed at the power houses. At present oil is being used in conjunction with coal.

Blackburn.—Members of the Blackburn Branch of the Electrical Trades Union decided on Friday evening to come out on strike as a protest against the employers reducing wages by 5 per cent., with a further 5 per cent. on July 9. There are 100 workmen affected in Blackburn, practically all of whom are in the service of private contractors. The employees of the Corporation Electricity Department are not concerned.

Swansea and Oil Fuel.—There is only about a month's supply of coal fuel at the electric generating stations, and oil fuel is suggested, and the committee have decided, subject to investigation, that oil-burning facilities should be installed, and plenary powers have been vested in the Chairman and Vice-Chairman to deal with the subject. The Borough electrical engineer (Mr. J. W. Burr) says that the necessary oil fuel, crude oil, could be obtained immediately from local sources, but oil burners could not be under a month.

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THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

BY SIR WILLIAM NOBLE, M.I.E.E.

(*Continued from page 271.*)

The necessity for extending the cable is due to the variations in impedance which result when a short line, that is, a line less than about 15 standard miles in length, is connected to lines or apparatus of differing impedances at the distant end. Such variations upset the balance of the repeater. If the line is sufficiently long, however, such connections do not sufficiently affect the balance to interfere with the working of the repeater.

As repeaters will usually be required to operate in tandem on long circuits, it is necessary that they shall be so designed that reflections are reduced to a minimum, otherwise irregularities will be introduced in the impedance/frequency characteristics of the line, as measured from a distant repeater station, and, in consequence of the out-of-balance thus produced at the latter station, the possible amplification will be reduced.

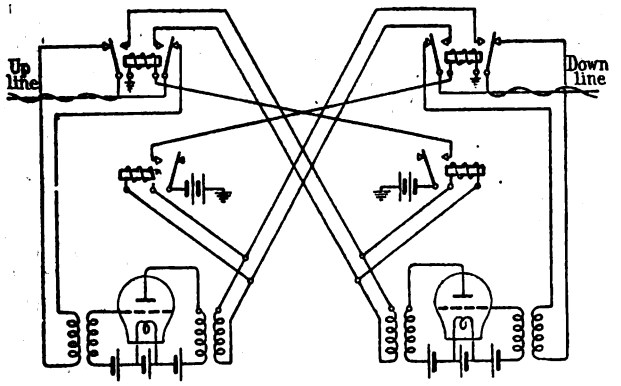


FIG. 12 (*a*).—TELEPHONE REPEATER WITH SWITCHING RELAYS (SCHEMATIC).

The difficulties in operating circuits using differential repeaters in tandem have induced investigations of other systems for obtaining two-way facilities.

Two such systems will be discussed. The first is an adaptation of the principle of the simplex telegraph repeater arranged for up and down working.

graph repeater, and are similarly controlled by the amplified outgoing currents. The principle of the system is illustrated in schematic form in Fig. 12. This principle has also been applied to wireless telephony.

The second system reverts to the original idea of using separate line circuits for transmitting in the up and down directions respectively. It is generally known as the four-wire system and is shown in schematic form in Fig. 13.

The speech currents circulate in only one direction around the circuit and are relayed by the one-way amplifiers in each side.

The terminal telephones or extension lines are connected with the four-wire circuit by means of the differential transformers T and T_1 and are balanced by the artificial lines RC and RC_1. If those balances are accurate and the transformers are perfectly differential, then the whole of the incoming current from the last amplifier in either side will divide between the terminal two-wire circuit and its corresponding balance, and no current will pass over to the other side of the four-wire circuit. Under this condition the repeaters could be operated with an amplification limited only by the cross-talk between the two sides of the four-wire circuit, and between adjacent circuits

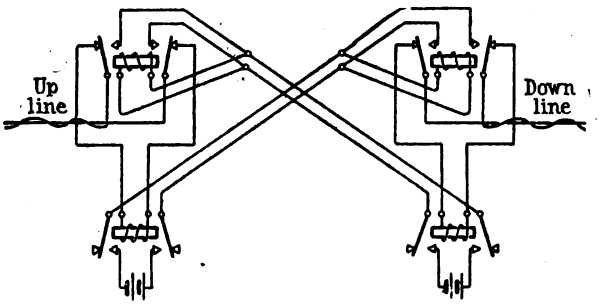


FIG. 12 (*b*).—TELEGRAPH REPEATER SIMPLEX (SCHEMATIC).

In practice the terminal balances can be made sufficiently accurate to enable the repeaters to be operated so as to give a transmission improvement equal to the suppression of an attenuation length not less than that of the total line circuit; that is to say, the overall transmission equivalent of the circuit between terminals may be zero. The repeaters must of course be so spaced along the circuit that the output energy at any station does not exceed the magnitude permitted by the cross-talk factor of the cable.

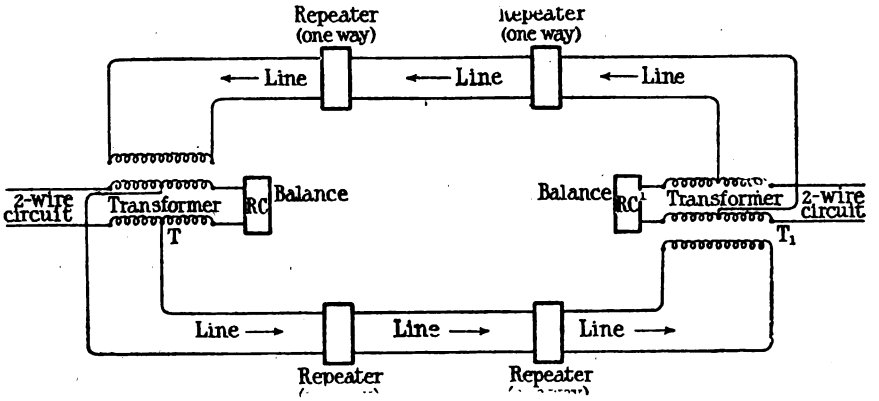


FIG. 13.—FOUR-WIRE REPEATER SYSTEM.

The line is divided at the repeater station, and the up and down sides respectively are led through the tongues and spacing contacts of an electromagnetic switch to the input circuit of an amplifier. The output circuit of each amplifier is cross-connected to the marking contacts of the opposite electromagnetic switch. The electromagnetic switches correspond to the automatic switches of the tele-

With modern balanced cables the repeaters may be spaced up to 30 standard miles apart with a reasonable factor of safety for commercial service; consequently very small conductors may be used. For long-distance cable circuits, beyond the economical range of the two-wire circuit with differential repeaters, the four-wire circuit offers important advantages and will be widely used.

Although the foregoing description of the telephone repeater is necessarily superficial it is thought that sufficient

* Paper read recently before the Inst.E.E.

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information has been given to facilitate an understanding of the extensive scheme on which the long-distance service in this country is now being developed.

Reference has been made to the London-Liverpool trunk cable and to the circumstances which led to its provision. Studies of traffic requirements between London and the Manchester and Leeds areas indicated the desirability of the same provision in these cases, and, but for the incidence of the war, a cable of similar capacity and efficiency to the London-Liverpool cable would have been commenced in 1914.

Revision of the scheme in 1918 with our later knowledge proceeded as follows :—

The trunk circuits were required to give a transmission efficiency of 12 miles of standard cable between test-boards. This efficiency could be obtained with cable conductors weighing 200 lb. per mile of wire, loaded with 100 mH per mile, and a cable of maximum diameter would provide 42 circuits including phantoms. Such provision would barely suffice for two years' development, and a second cable would have to be commenced immediately on completion of the first. The development at the end of eight years would require several such cables, for which duct space should be provided at the outset.

Now assuming the installation of a midway repeater giving a transmission improvement of 14 miles of standard cable; then for an equivalent of 12 standard miles between terminal test-boards a cable containing 100 lb. conductors would be suitable. A cable of maximum diameter would provide 90 circuits including phantoms. The annual costs per circuit including repeaters would be approximately one-half that of the previous scheme, and the provision of a second cable would be postponed for about three years.

Further, assuming the installation of two intermediate repeaters each giving a transmission improvement of 14 standard miles, then the required efficiency between terminal test-boards could be obtained with cable conductors weighing 40 lb. per mile of wire, and the cable would provide 240 circuits including phantoms. The total annual charges per circuit would be approximately one-third those of the first scheme.

(To be continued.)

ANTI-DUMPING.

It is proposed in the first Resolution (Key Industries) dealing with the Safeguarding of Industries introduced in Committee of Ways and Means that a duty of 33⅓ per cent. be charged for five years on certain articles imported into Great Britain and Ireland. Included are galvanometers, pyrometers, electroscopes, wireless valves and similar rectifiers, vacuum tubes, ignition magnetos and permanent magnets, metallic tungsten and manufactured articles of tungsten, etc. The second Resolution deals with "Anti-Dumping," and proposes a duty of 33⅓ per cent. in addition to any other duties of Customs on articles "dumped" in Great Britain or Ireland at prices below cost of manufacture in this country.

In connection with the above the British Empire Producers' Association maintains rightly, we think, that the desired effect can only be obtained if the duty is not fixed at 33⅓ per cent., but adjusted to the different articles specified by a standing Commission, being sometimes less and sometimes more. The Association further contends that the Commission should have power to add to the list of key industries, and that a 50 per cent. reduction of the additional duty be made on goods manufactured within the Empire. Other suggestions are also made, and it is further contended that the electrical industry should be included in the key industries as "electricity as power is one of the most essential raw materials, and so wants special consideration. Backwardness before the war was due to two causes :—(1) Free import; (2) Municipal trading. No firm could extend works according to the possible demand of the Empire, as the effect of free importations into this country created a demand for every system, whilst in America and Germany there was standardisation. The result was that the output of our biggest firms was only 10 or 15 per cent. of the output of the German A.E.G. or American General Electric."

On the other hand the Importing Associations naturally take the view that imports generally should be unrestricted. Now to reduce the cost of living and to keep prices and profits down to a reasonable level, there must be competition, and therefore we would urge that as far as possible free imports be allowed at the earliest opportunity. Obviously if rates and taxes on manufacturing enterprises could be drastically cut our manufacturers could produce more cheaply, that is, the real cure is in decreased Government expenditure. As the Resolutions have been agreed to we are apparently committed to a semi-protectionist policy for a period of five years unless opportunity arises for revision.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 117.

The construction of stone cellular type switchboards is not generally understood. Please can you give me some idea of the contents of a cell for, say, a generator panel? What safety and protective devices are necessary to make the cell foolproof?—"TRANSFORMER."

QUESTION NO. 118.

What is the principle of operation of auto-transformers for starting induction motors? Is this method to be preferred to the ordinary starter, and is it cheaper?—"STATOR."

(Replies to Questions Nos. 117 and 118 must be received not later than May 28, 1921.)

Answers to Questions.

REPLIES TO QUESTION NO. 115.

No replies of a satisfactory nature were received to this problem. It has, therefore, been decided not to make an award.—Editor, ELECTRICITY.

Tramway Track Construction.—It is possible that quite a number of our readers who are employed in various capacities in electric traction undertakings may be interested in the subject of Tramway Track Construction, and in such case we cordially recommend to their careful perusal "Tramway Track Construction and Maintenance," by R. Bickerstaffe Holt, the price of which is 12s. 6d. net post free from this office. It is a splendid book of just on 250 pages, and is beautifully illustrated with 178 diagrams and plans. Published in 1915, it is undoubtedly the best book on this subject from the point of view of English practice, and we have no doubt that it will continue to meet with a steady sale.

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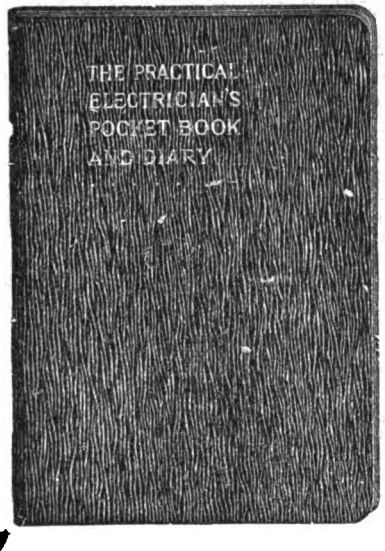
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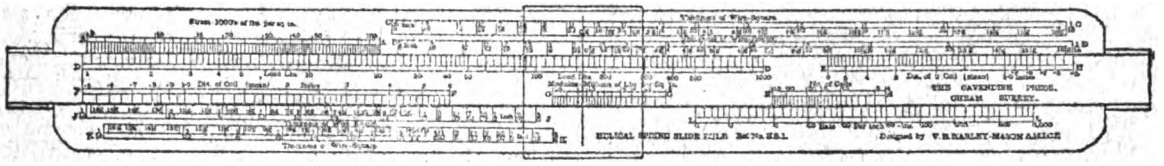
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THE CAVENDISH HELICAL SPRING SLIDE-RULE.

We have received from the Cavendish Press, Cheam, Surrey, a very useful slide-rule for the various calculations connected with helical springs. It has eleven separate scales, but its appearance belies its apparent intricacy for it is quite simple to work.

Given the load and stress it is perfectly easy to read off the wire thickness for either round or square wire, and if it is desired to use a certain size wire the necessary diameter of coil can be calculated in a similar manner. It is also possible to find the stress or load which different springs will stand.

Similarly, the deflection can be calculated; a single setting giving the number of coils for any required rate per inch for any spring.



Made of compressed cardboard covered with celluloid and complete with cursor it is priced at 7s. 9d. (post free), and it should prove most useful to designers and draughtsmen, or, indeed, to all whose work brings them in contact with helical springs.

ALL ABOUT BOILER BREAKDOWNS.

By H. S. B. ROBINSON.

Although boiler explosions are fortunately not frequent, the same care should be exercised to avoid possible damage, expensive delays and also waste of fuel, as economy in the use of coal is a matter of great and growing importance in connection with Central Station Electricity supply.

While discussing the various causes of explosion, it is hoped that the few practical suggestions mentioned below may not only be of interest to the reader, but the means of averting any serious danger should an occasion arise.

It is a curious fact, yet one worthy of mention, that many boilers explode in getting up steam, as they will be very hot in some parts, while other parts will be actually cold, and under these conditions enormous strains must occur in some portions of the boiler, which are repeated every time steam is raised. There are several causes of unequal expansions, and also of weakening by burning and blistering the iron, consequently it is proposed to discuss them separately.

Corrosion.—The accumulation of scale on the interior and of soot on the exterior will seriously affect the efficiency and economy of boilers. Only one-eighth of an inch deposit of soot renders the heating surface practically useless and half this amount of scale or sediment will cause a considerable loss in fuel. In all cases where impure or hard waters are used, frequent blowing off is necessary to carry off the accumulated matter which, if allowed to remain, would form scale. The frequency of the operation would depend entirely upon the condition of the water, but in any case the boiler should be emptied every week or two and filled up afresh. By removing the hand-hole caps at both ends of the tubes and holding a lamp at one end and looking in at the other, the condition of the surface can easily be seen. The scraper should be pushed through the tube to remove sediment, but if the scale is hard, the chipping scraper should be used. Water through a hose will facilitate the work. When replacing hand-hole caps it is necessary to clean the surfaces without scratching or bruising, smear with oil and screw up tight. The exterior of tubes can be kept clean by the use of blow-pipe and hose or, in using smoky fuel, it is best to occasionally brush the surfaces when steam is off. When boilers are coated with a hard scale difficult to remove, it will be found that the addition of a small quantity of caustic soda and steaming for some hours according to the thickness of the scale, just before cleaning, will render the scale soft and loose. This should be done if possible when boilers are not otherwise in use. Nearly all waters contain foreign substance in greater or less degree, and though this may be a small amount in each gallon, it becomes of importance where large quantities are evaporated. For muddy water, preventatives of incrustation seldom prevail, except filtration.

Low Water.—In many boilers, the fall of only a few inches in the water line will cause some portion to be exposed to the direct action of the fire, consequently it becomes quickly overheated and weakened to such an extent that an explosion is likely to occur. Glass gauges should never be relied upon, but if low water is observed after trying gauge cocks, the importance of neither turning on the feed, starting or stopping engine, nor lifting safety valve until fires are out and the boiled cooled down cannot be over-estimated.

Cold Water.—Pumping in cold water causes strains from difference of expansion and sometimes leaks, which should be avoided where possible, but, if necessary, it should be mixed with the heated water before coming into contact with any part of the boiler.

Owing to lack of space, further causes of breakdowns will be discussed in a subsequent article.

HINTS ON LOCALISING AND EXPEDITIOUS METHODS OF REPAIRING FAULTS IN COLLIERY A.C. PLANT.*

By E. CUNNINGHAM.

(*Continued from page* 258.)

On the opposite pole the inside coil had also shorted on to the ring and the copper was badly damaged. The conductors in the slot are arranged in two layers side by side, the conductor consisting of rectangular stranded copper wire with braided cotton insulation. The top conductor of the inner layer of this coil was badly damaged close into the slot and on easing it up it broke off just inside the slot. You will see from the type of winding (Fig. 5) that to rewind the inner coil would mean stripping out the complete coil forming one pole, or in other words half the winding of the rotor.

Now to get continuity of the coil the conductor below this one was raised up and the insulation stripped off and the broken conductor was joined to this by means of three copper clips and then soldered and reinsulated.

The damaged insulation on the other parts was renewed and new corner wedge pieces fitted. An ohmic resistance test was made with the 2 volt accumulator and the following readings were taken:—Voltmeter 1·6 volts, ammeter 2.7 amps., and this equals a resistance of 0.59 ohms.

A current test was then made to see if any arcing would take place before the cylindrical ring was replaced.

The exciter leads from another set were coupled to the slip-rings and a current of 70 amps. was passed through the winding and maintained for three minutes. This test appeared to be quite satisfactory and the magnetic effect of the iron was very convincing.

* Paper read at a meeting of the Lothians Branch of the Association of Mining Electrical Engineers, Edinburgh, on November 27 With acknowledgments to *The Mining Electrical Engineer.*

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A layer of leatheroid was placed over the coils and bound down with a layer of superfine tape to keep it in position. The end ring was then screwed on without any difficulty, the rotor fitted into the stator and the whole machine coupled up. The set was then run up and put on load for six hours without a hitch. Fig. 6 shows the rotor in position in the stator.

This set has been in commission for ten years and this was the first electrical breakdown since it was installed.

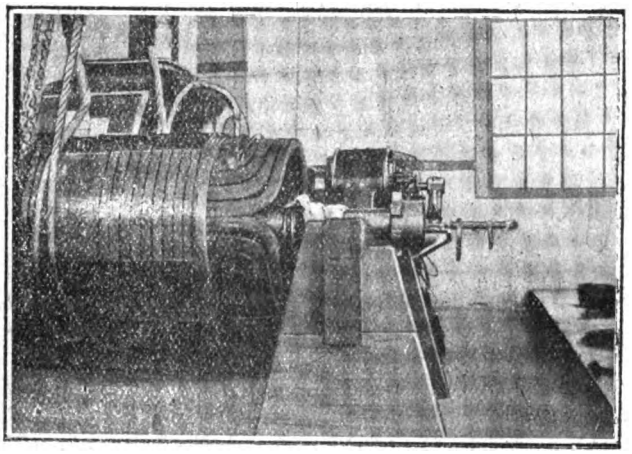


FIG. 5.

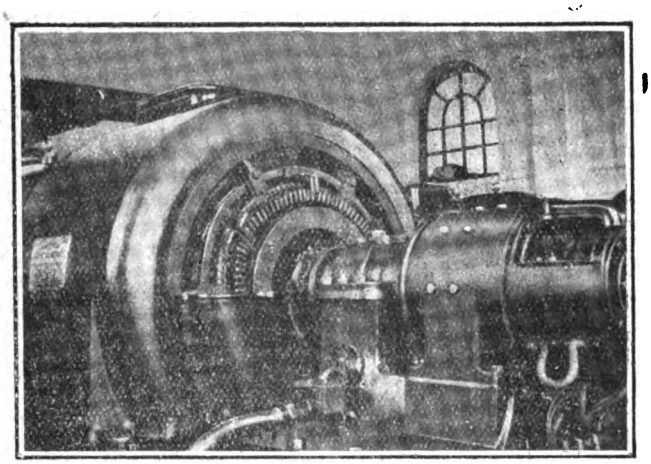


FIG. 6.

If this machine had been returned to the makers the rotor would have been stripped and rewound, which would have taken probably three months' time, whereas this repair was carried out in seven shifts of eight hours.

The writer, in conclusion, trusts he has shown from the foregoing how considerable time can be saved and consequently the output of coal maintained and increased.

DISCUSSION.

Mr. F. Sims opened the discussion by expressing gratification with the very enjoyable and instructive paper. He was sorry Mr. Cunningham had finished so early as he was getting most interesting with the various points. He liked Mr. Cunningham's idea of taking a certain amount of stuff such as washers, mica, leatheroid, etc., down the pit to a breakdown, but it was not always convenient to carry a lot of material. The testing lamps he mentions for locating faults were very useful indeed. Personally he (Mr. Sims) had used them for a number of years and he would never be without these, as he, too, had found them more useful and practical than a megger in many cases.

Regarding breakdowns, Mr. Sims thought that a great deal of running about might be avoided by periodical tests being taken at least once a month and records kept of same. For instance, in slip-rings, a small touch and a look now and then very often saved a breakdown. Mr. Cunningham's various repairs were very ingenious and so also were his methods of testing, especially the compass set.

In regard to breakdowns in coal cutters, this (said Mr. Sims) was a machine the very name of which often made an engineer screw up his face. A frequent cause of coal cutter trouble was the jamming of the mechanical end. He remembered having to send a man to a coal cutter where it was stated the switch was out of order. The man went to repair the switch, and being stuck, got another one to help him and both were defeated. In the end Mr. Sims found it necessary to go down, and he found that all the trouble could have been avoided if they had thought of disengaging the gearing. It was there where the fault lay, not in the electrical end at all.

Mr. Sims continued by surmising that many of the members present would have points to bring forward, and he knew Mr. Cunningham would welcome criticism. They all wished to get the benefit of each other's experiences just as Mr. Cunningham had given them the benefit of his.

Mr. D. S. Munro.—The lesson of the paper was that foresight, order, and method make for expedition. All were fairly well convinced that it was wise to have diagrams, periodic inspections and methodical records, but few of them really keep these up to date—unless they had perhaps an amenable yet capable assistant who could be impressed into doing this work for them.

A well-planned repair outfit such as Mr. Cunningham details should always be readily accessible and kept in one or more light portable cases ready for instant use. Too often time was lost by searching around for materials in odd corners, making up test lamp appliances, etc. Where there were many motors or coal cutters, two or three locked boxes containing small spares such as brushes, contact fingers, washers and insulating material, might with advantage be placed at strategic points underground.

The megger and galvanometer could with advantage be replaced for some classes of rapid test by a four-barred magneto fitted in a box with buzzer. It was convenient for working in dark places where a scale is difficult to read and would operate through 50,000 ohms; for rough leakage tests and for fault finding this was very often sufficient.

Cable breakdowns, as Mr. Cunningham had pointed out, were not now so frequent. Still they did occur. With bitumen mining cables, one dare not adopt too freely the "burning out" method of clearing faults because of the harmful softening and consequent decentralisation apt to be caused.

With expensive cables one should not be too quick to adopt the "cut and try again" way of location. One of the chief troubles in connection with the finer "Bridge" tests was in finding out the exact sizes and lengths of the cables. On town distributors where cables were laid on the level the work was comparatively simple, but in a mine with loops and sags and crossings and bends galore, it was no easy matter to measure exact lengths. It would therefore be of great service if all distributor and feeder cables were clearly marked locally with their size, type and length between boxes.

Disconnecting links in the boxes were a great help in time of trouble with cables.

Personally he, Mr. Munro, held that the "coil of fine wire and telephone receiver method" of locating a leak or short was more generally useful than the dial compass method—of course with armoured cables there were difficulties in the way of using the telephone receiver. The compass needle was aggravatingly slow to come to anything approaching rest, and if there were alternating currents or magnets about, then it would come to rest in the wrong position.

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The vertical shaft cable fault which Mr. Cunningham referred to was ideal for the compass and he understood that the passage of the current in the cable had magnetised the armouring. No doubt much could be done to lessen risks of breakdown if the first layout of the A.C. distribution included automatic protective gear and leakage indicators. Mr. Cunningham had given particulars of interesting repairs to motors. The "cutting out" or "shorting" of windings may, however, sometimes prove a risky experiment for they tended to produce temperature or magnetic variations and often led to more serious breakdown if the permanent repair be too long delayed.

There were emergencies, however, in which it was necessary to make these connections to keep the work going. Bad contacts between rotor bars and the short circuiting rings were formerly a frequent cause of trouble, but with the coming of casting-on of end rings the faults were not so common. Soldered joints and connections in stator or rotor had always to be considered as weak points and melted solder had an unfortunate habit of solidifying again, perhaps in a critical crevice.

Those who had seen or used some of the new electrical welded outfits wished that motor manufacturers would at once proceed to apply this excellent process to many of the points in armatures and rotors which were at present soft soldered.

The paper showed that its author had tackled some pretty tough jobs and undoubtedly he would look forward to the day when the British manufacturers would send along (by high-speed electric train) a replacement whenever it was called for, instead of saying, as they did now, that the order would be fulfilled in 52 weeks subject to strikes, lock-outs, disputes, arbitrations, conferences, etc., etc. However, nothing teaches like adversity, and probably the best part of an electrical engineer's training began when he was called upon to locate and repair faults.

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

"PRACTICAL TESTING OF ELECTRICAL MACHINES." By L. Oulton, A.M.I.E.E., and N. Wilson, M.I.E.E. (Pitman, 6s. net.)—This book, originally published in 1909, has been revised and a chapter has been added which deals with the testing of transformers. This additional chapter adds to the value of the book, although its previous contents are valuable to those engaged in the testing of electrical machinery. The outstanding feature of the book is, probably, the detailed tests on induction motors. Here, of course, the Heyland diagram is explained in detail in a manner that can be easily understood. In another portion of the work, the tests of alternating current generators are adequately dealt with. This information should be appreciated by those engaged on the outside constructional staffs of our large electrical engineering companies. Another interesting feature is the section allocated to the testing of single-phase railway motors Electric traction will come greatly to the fore in the near future. Those interested in alternating current traction will be sure to appreciate this portion of the work. Direct current railway motors are very clearly dealt with. The book is to be recommended to all engaged in the erection and testing of electrical machinery.

"USEFUL ENGINEERS' CONSTANTS FOR THE SLIDE RULE." By J. A. Burns. 3rd edition. (Percival Marshall and Co., 2s. net).—This is another of those eminently useful and practical manuals for which Messrs. Percival Marshall and Co. have gained such a high reputation. It shows in a concise way how a slide rule may be used to the best advantage in solving problems which the practical engineer meets with every day, and is an excellent aid to rapid calculation. In this new edition a certain portion of new material has been added, and in the "Weights and Measures" section the quantities have been extended to more figures than can be read from the scale of an ordinary slide rule; an extension which will render the book even more useful than before. It can be cordially recommended to our readers.

ELECTRICITY SUPPLY, 1918-20.—This publication, which has just been issued by the London County Council, and the price of which, with maps, is 5s. (5s. 3d. post free), is a return relating to electricity supply in the London and Home Counties Electricity District as provisionally determined by the Electricity Commissioners under the Electricity (Supply) Act, 1919, showing the various authorities under the Electric Lighting Acts, 1882 and 1888, with the authorised areas of supply; together with an analysis of the accounts of each undertaking for the year ended March 31, 1919 (December 31, 1919) and also miscellaneous statistics relating to capacity, output, prices, assessments, etc. It contains a very large amount of matter which will interest central station engineers in all parts of the kingdom, and the maps, which are in colour, are remarkably clear and informative. It is altogether a publication which is well worth perusal by supply engineers and local authorities.

SMALL SINGLE-PHASE TRANSFORMERS. By E. T. Painton, B.Sc., A.M.I.E.E. (Pitman, 2s. 6d. net.)—This little book will be appreciated by many classes of the electrical engineering community from the fact that it deals very well with a very important subject. The author truly says that up to the present time the design of small transformers has received little attention. In this small volume the small transformer, its principles of operation, regulation and efficiency, and requirements and typical design are adequately dealt with. There appears to be only one fault and this is not of a technical nature. In the appendix the derivation of formula for single-phase transformers is given. The symbols are not complete. To make them so, the student is referred to Chapter 6. It would have been much better if the whole of the fomula had been given, thus avoiding the tiresome and unappreciated method of *referring back* which make some of the older books a nuisance. The book is illustrated with 40 exceptionally clear diagrams.

Correspondence.

SYNTHETIC RESINS AND VARNISHES.

To the Editor of ELECTRICITY.

Sir,—The Electrical Research Association is actively interested in furthering the manufacture and use of electrical insulating materials made from synthetic resins and varnishes, and having the well-known heat resisting characteristics associated with some of these materials.

Leading manufacturers and users of the raw materials and finished products are already co-operating, and it is hoped that you will be so good as to insert this letter in your journal so that persons not already in touch with the work may have the opportunity of communicating with the undersigned.

Yours faithfully,
E. B. WEDMORE,
Director and Secretary British Electrical and Allied Industries Research Association,
May 10, 1921. 19, Tothill Street, Westminster, S.W.1.



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Trade Notes.

An illustrated folder from **Z. Electric Lamp & Supplies Co., Ltd.** (73, Newman Street, W.1.), gives the reduced price of the Electrolux Suction Cleaner.

The General Electric Co., Ltd. (Magnet House, Kingsway, W.C.2) have issued a leaflet illustrating and pricing 14-volt Osram lamps for use in electric signs. There are two sizes of lamp, 2.8 and 7.0 watts respectively, and they can be supplied with S.B.C. and S.E.S. as standard caps.

Perfecta Seamless Steel Tube and Conduit Co., Ltd. (Plume Street, Birmingham) have prepared a four-page leaflet dealing with the size of steel tubes in greatest demand. Weights, prices and other particulars are given. The tubes are designed primarily for cycles, motors, aircraft and general engineering purposes.

The "Installation and Operation of Metropolitan-Vickers Power Transformers" is the title of Instruction Book No. 5370/1 issued by the **Metropolitan-Vickers Elertrical Co., Ltd.** (Trafford Park, Manchester). It is a most useful publication, of handy size, and fully lives up to its title. Particulars are given concerning drying out, oil filtration, drying and purifying, repairs, etc.

From **Donovan & Co.**, Electrical Manufacturers and Suppliers, of 47, Cornwall Street, Birmingham, we have received an illustrated price list No. 1421 which illustrates and prices at current rates the whole of the lines likely to be used on ordinary installations for housing schemes, private house wiring and works wiring, which list will be sent to any interested firm on receipt of a trade card, when discounts will be quoted.

The General Electric Co., Ltd. (Magnet House, Kingsway, W.C.2.), are issuing two window showcards demonstrating in a simple manner the case for the use of Osram Gasfilled lamps instead of Osram Vacuum type lamps. One card deals with the 40 watt gasfilled lamp and the other with the 60 watt. Dealers and suppliers may find these cards of value as a help in getting the general public to appreciate the place of the gasfilled lamp.

The Metropolitan-Vickers Electrical Co., Ltd. (20, Trafford Park, Manchester), have just issued Circular No.1426, dealing in a general way with Metropolitan-Vickers Turbo-Alternators. The publication is amply illustrated with half-tone and diagrammatic blocks, and the construction of the stator or rotor is fully set forth. So also is the "radial axial" system of ventilation, while reference is made to the construction of the exciter with radial commutator, whereby difficulties of current collection due to cross-axial vibration are overcome. Illustrations of machines up to 25,000 K.V.R. are given, together with lists of machines installed or on order, included being two of 31,250 K.V.A. each for Manchester Corporation (Barton).

The "Howarth" portable cinematograph projector is priced, described and illustrated (diagrammatically with a list of all component parts) in a leaflet received from **Howarth Portable Projector** (26, Church St., Charing Cross Road, W.C.1). It is entirely constructed of metal, has two fireproof spool boxes and chain take-up, and in all other ways complies with the conditions of the Cinematograph Act. Where no supply is available accumulators can be used.—Another leaflet refers to the firm's Automatic Day and Night Advertiser, an electrical device exhibiting ten pictures (of dia. about 14 ins.) automatically for three to five seconds each in daylight. At night or in diffused daylight pictures 3 ft. 6 in. dia. can be exhibited on a screen. It should merit investigation as a novel advertising device.

An addition is made to the convenient series of catalogues measuring 8½in. by 5½in. issued by the **Sun Electrical Co., Ltd.** (118-120, Charing Cross Road, W.C.2), by list No. 313, Electric Switch and Fuse Gear. It embraces the Apex switchgear, Sunco H.O. fuseboards, ironclad switch fuse gear, knife switches, accumulator charging panels, etc. Other of the Sun Company's recent leaflets and folders include one dealing with the well-known Xcel electric iron, the "Sunshine" Suction Cleaner, the A.B.C., Super Electric Washing Machine and Wringer, and the "Lesco" Lamp Holder. The "Sunshine" cleaner is provided with a spiral brush rotated direct from the wheels of the machine, and is so designed that the cleansing air is drawn over, under and through the meshes of the rug or carpet being cleaned. It is claimed that only the "Sunshine" combines all these points, which are, without doubt, most valuable ones. A feature of the A.B.C. Washer is that the soiled fabrics are rocked and tossed to and fro *as well as* being lifted and dipped in the sudsy water. The folders dealing with both the cleaner and washer are particularly well conceived and executed.

Credenda Conduits Co., Ltd., now have a Glasgow office at 97, Waterloo Street.

Salterns, Ltd. (Parkestone, Dorset) have taken over the manufacture and sale of hydraulic turbines and accessories to the design and under the supervision of Mr Percy Pitman, M.I.Mech.E., lately carrying on business at 25, Victoria Street, S.W.1. A new catalogue is in preparation, and will be forwarded to those interested in the development of water-power on application as soon as it is completed.

Osram Folder, D.S. 2393 issued by the **G.E.C.** groups Osram Gasfilled lamps thus:—For private house lighting, etc., 40 and 60 watts, 100-260 volts, for low-voltage circuits 20-65 volts, 15, 30 and 60 watts, and for the lighting of large areas 100, 200, 300, 500, 1,000, and 1,500 watts in various voltages. The method is rather convenient, and the folder may be of considerable value as an appeal to small consumers.

The most recent Wireless Catalogue issued by **Economic Electric Ltd.** (10, Fitzroy Square, W.1.) is a distinct advance on the preceding one. It has been increased by 8 pp. and now runs to 28, all conveniently and compactly arranged, and containing particulars of the apparatus and accessories required in smaller wireless telephonic and telegraphic stations. We note especially two features: (1) There is a helpful contents index and (2) prices have been materially reduced all round.

Various Items.

Motor for Sale.—An advertiser has for sale a 10-h.p. motor and starter. For particulars see a small advert.

Preston.— In view of the coal shortage an oil-burning set has been installed at the Corporation Tramways power station.

Situation Vacant.—A skilled founder and electro-plater is wanted to assist in working up a business in London. For full particulars see a small advert.

Inst. C.E.—At the annual general meeting Mr. W. B. Worthington was elected president for the year, beginning in November. Among the ordinary members of Council are Colonel R. E. B. Crompton, Capt. H. Riall Sankey, and Sir John F. C. Snell.

Ammanford.—The R.D. Council has decided to instal electric light in all their houses. Lamps will be fitted in all the rooms on both floors, and the architect (Mr. David Thomas) states that the sum of £10 was included in the contract prices of each house for this purpose.

Cheers.—The removal of the offices of the Institution of Electrical Engineers to its own building will begin on Tuesday, May 17, and on and after that date all communications to the Institution should be sent to Savoy Place, Victoria Embankment, London, W.C.2. The telephone number will continue to be Gerrard 764, and the telegraphic address, "Voltampere, Phone, London."



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ELECTRIC LIGHT WIRING SYSTEMS

An essentially practical paper on electric light wiring systems was read at the meeting of the National Association of Supervising Electricians on Tuesday, May 10, by Mr. F. T. Alldread, in which the advantages and disadvantages of various wiring systems were reviewed.

A screw conduit installation efficiently carried out should consist of heavy gauge steel tubing, preferably solid drawn, although both welded and brazed conduit of the same gauge have proved fairly satisfactory. The chief advantages of the conduit system were stated as follows:—

(1) Good mechanical protection to the V.I.R. wires, and very suitable for burying in walls and ceilings.

(2) If properly installed, the wires can be easily drawn out when faulty, and new ones replaced without disturbing the decorations.

(3) If desired, the system can be made practically watertight.

(4) Complete protection from fire due to electrical causes is given in buildings where this system is installed, except at the fittings and switches.

The disadvantages of this system are:—

(1) The V.I.R. wires being encased in a conductor at earth potential (usually at the same difference of potential as the supply voltage) are always under electrical stress which tends to break down the insulation, and is usually quite successful in doing so wherever the same is weak, even though not low enough to be dangerous.

(2) The conduits being watertight (at any rate wherever dips without joints are made) any moisture that is collected is held, which corrodes the conduits causing chemical action to take place in the insulation of the wires, and thus causing breakdowns.

(3) If installed in places where there is an excess of moisture in the air, the conduits will very quickly corrode and thus attack the insulation as before mentioned, or if lead-covered wires are used instead of braided V.I.R., electrolytic action will occur between the lead and steel, thus causing the steel to be eaten away, this action being greatly accentuated in places where the air is charged with damp salt or acid, such as by the sea shore, in large kitchens, stables, chemical factories, etc.

(4) The system is very expensive to install and cannot be used on the surface where appearance is of consideration.

Steel conduit with continuity grip couplings make a fairly good substitute for screwed conduit, with the advantage that it is somewhat cheaper, but cannot be used in places where it is desired to make the conduit work watertight. Steel conduit with plain "push-on" couplings is a system which has been condemned by the Institution of Electrical Engineers and most of the fire offices, although it is still being used very largely in the cheapest class of work. Mr. Alldread did not, therefore, comment on this system, although he stated it is an open question as to its suitability in small installations in dry buildings, such as private houses.

Wood casing and capping was recommended as an excellent system where installed on the surface in dry buildings, there being no danger from electric shock, and very little, if any, with regard to fire from electrical causes. Such installations would last a very long time; in fact, provided the wires were not disturbed, the installation would be quite efficient long after the insulation had perished. However, at present the first cost was practically the same as screw conduit, which Mr. Alldread regarded as a disadvantage, whilst another disadvantage was the difficulty of obtaining efficient labour, the average wireman usually having very little skill in handling wood casing to-day.

Discussing lead or alloy-covered wires, fixed direct on the surface of walls and ceilings or under floors by means of saddles or straps, the author stated that either of the various systems of this type, or plain lead-covered V.I.R. wires, form an efficient and durable installation under suitable conditions, and generally are considerably cheaper than either screw conduit or casing. All of these systems, however, were more or less subject to mechanical damage. Whilst the harder the alloy used the more immune would the system be, yet it was found in practice that the harder the alloy the more difficult and expensive it was to install. Where fixed on the surface, especially with plain lead or the softer alloys, the wires were very liable to sag on horizontal runs, even though the fixings had been put in at very short intervals. Thus these systems were apt to be unsightly. Most of the makers now made up two or three wires in one casing, so that it was possible to carry out the wiring to points and switches with only one casing, thus improving the appearance. One great advantage was that if the ends were properly protected the wires were immune from damage due to impurities or damp in the air.

Coming to hard rubber-cased V.I.R. wiring, so-called cab-tyre, Mr. Alldread said he was unable to state personal experience of installations on this system that had been erected for any lengthy period, but the following disadvantages had been noted:—The rubber casing has a tendency to crack and open where the wires have been bent to a very sharp angle, thus exposing the insulation to any damp or corrosion that may be present. This has been found to occur, however, only after the installation has been in use for one or two years. Again, this wiring is more or less ragged and unsightly where installed on the surface, as a certain amount of sagging on horizontal runs is unavoidable.

For factory and similar purposes, ordinary V.I.R. braided cables fixed by means of porcelain or other cleats form very serviceable and cheap installations, but extra protection must be given where the wires are liable to mechanical damage. The insulation of the wires, being only of a secondary nature, especially on pressures of 100 volts and lower, the cheaper grades of wire can be used, and once installed, can generally be relied upon to last a great number of years, even after the insulation itself has perished. In chemical or salt-laden atmospheres, however, the very highest grade of rubber insulated wire should be used.

In buildings which have lofty roofs or ceilings, and appearance is not important, successful use may be made of bare copper or aluminium wires stretched tightly on porcelain insulators, but any wiring that has to be within reach must be insulated and protected. A combination of V.I.R. cleat wiring and bare conductors forms the cheapest class of installation in certain buildings, and will generally be found to be very durable and free from faults. Another similar system is that of flexible insulated wires on button insulators, which has been very much used on the Continent.

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A long and interesting discussion followed, in which many differences of opinion manifested themselves. Cab-tyre cable, in particular, came in for much comment. It was suggested that the manufacturers of this type of cable were not wise in claiming that it is suitable for any and every set of conditions, and instances were mentioned in which has proved extremely successful. On the other hand, one disadvantage of it to which attention was called was the ends of the cable, which, it was said, are too often exposed to the elements. Reference was also made to the variation of policy on the part of different supply authorities in regard to allowing the use of cab-tyre, Stannos and similar systems to be carried under floors, and some speakers failed to appreciate the difference between this and ordinary wiring in wood casing under floors.

Mr. Crowdy, who represents the Association on the Institution of Electrical Engineers Wiring Rules Committee, spoke of discussions by that body which had resulted in passing a resolution in favour of running two wires of opposite polarity in wood casing without the intervening fillet. The reason put forward for this was that more fires had occurred through the wood fillet than from any other cause, but subsequently this decision was rescinded. A strong plea for the V.I.R. cleat wiring was put in by Mr. Revell, who spoke of 26,000 lights installed on this system by 1913 in the permanent barracks at Aldershot. In this installation the greater part of the repairs were said to be due to wilful damage, but the whole work of maintenance was managed by one man and two boys. An earth seldom occurred, and a fire was unknown.

The proportion of wages to total cost was also commented upon. Mr. Alan Kirk said that in 1913-14 the cost of labour was about 25 per cent. of the total, but now it was 60 per cent. Mr. Alldread, in his reply on this point, said he would put the present day cost of labour at a higher figure than that, because his experience was that it amounted to from three to four times the pre-war figure. Another matter which drew some discussion was the quality of workmanship. Some speakers were more or less general in their condemnation of the lower quality of work to-day compared with that of some years ago, and in particular it was stated that present-day wiremen had very little skill with wood casing. On the other hand, it was pointed out that the apprentices now coming from the trade's training schools show a very high standard of workmanship, equal, if not bettter, to that of the old-fashioned wireman, whose good work is so often commented upon in discusions on electric wiring. Differences of opinion also manifested themselves on the author's statement that wood casing costs as much as screw conduit. One speaker said that wood casing did not cost more than half that of screw conduit, but Mr. Alldread replied that his view was based upon recent estimates, and he found it quite as cheap to put in screw conduit as wood casing. Another practical point touched upon was how best to overcome the difficulties created by condensation, and the useful suggestion was made that holes should be drilled in draw boxes and elsewhere to provide an efficient ventilation of the conduit and so keep it thoroughly dry. Whatever differences of opinion were found to exist upon the practical details, there was unanimity of opinion that the one aim should be to reduce the cost of wiring, consistent with efficient work, to the lowest possible point, if the hope of seeing all houses wired for the use of electricity is to be realised.

The British Engineers' Association.—The annual general meeting of the British Engineers' Association took place at 32, Victoria Street, London, S.W. 1, on Thursday, 12th inst., and at a meeting of the Council of the Association that followed, Mr. Nevile Gwynne, late Chairman of the Executive Committee, was elected President of the Association, in place of the retiring President, Colonel O. C. Armstrong, D.S.O., who had occupied the position of president for three years, and to whom a very hearty vote of thanks was accorded. Mr. E. W. Petter was elected Chairman of the Executive Committee in succession to Mr. Nevile Gwynne.

THE POSSIBILITIES OF ELECTRIC HEAT ACCUMULATOR STOVES.

During a lecture to a society of engineers in Switzerland, Herr Paul Beuttner stated that electric heat accumulator stoves are now made on three systems: (1) By means of hot water. When the water is heated to 120° C. and cooled to 40° C. an accumulating capacity of 71,000 heat units is produced per cubic metre of storage capacity. (2) By means of steam under a pressure of 13 atmospheres. In this case the accumulating capacity when the steam is cooled from 190° C. to 110° C. is 68,000 heat units. (3) By means of a solid block of material heated to 500° C. When cooled to 200° C. the accumulating capacity is 90,000 heat units.

The heating stove at present in use requires during a short space of time a large amount of current, particularly in the morning and evening, which on technical grounds is a great drawback. The modern accumulator stove is continuously heated for 15 hours (the lighting hours being excluded). The rate of use of current during the time mentioned is small, and the temperature available in the stove is so high that at any time meals can be cooked. Experiments which were made under the supervision of the Electrical Society proved that the following amounts of current were used for cooking the meals of an average large family:—

	K.w.-hours.
For the morning meal	0.87
For the mid-day meal	3.00
For the evening meal	1.95
Amount allowed for losses in current ...	6.50
Total ...	12.32

In addition, water is at the same time heated for washing up. This consumption of 12.32 k.w.-hours entails a demand rate of 0.8 k.w. during 15 hours only; thus it is possible to attach the accumulator stoves to any lighting circuit. At rates charged in Zurich the actual cost per day is 1.25 frs. where electric current is used directly for cooking the meals of an average family; where used in an accumulator stove the cost would be 0.79 frs. per day; or assuming a night current price of 3 cents, the cost with an accumulator stove would be reduced to 0.45 frs. These accumulator stoves, which are heated by warming rods of silicium carbonate* can be arranged to burn wood or coal in case the current were cut off owing to a scarcity of water or other reasons.

The use of electricity for heating has spread rapidly in certain industries, particularly in the case of baking ovens, which are also made to use the silicium carbonate rods. It should be noted that every variety of baking oven is adaptable for electrical heating. The alterations necessary can be carried out in a few days, and in such a way that, although the current is meant to be used regularly, the oven may be stoked with coal or wood should it be found necessary.

The Electricity Supply Undertaking in the Lyons (France) district has now agreed to a special tariff (about ½d. per unit) for heat accumulating appliances operated during the night.

Have the possibilities of this method for our own country been investigated as they might?

*Silicon Carbide, Silundum or Silicon Oxycarbide is probably intended.

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INDUSTRIAL ILLUMINATION.

COMPLETE BENJAMIN CATALOGUE FOR CONTRACTORS AND ENGINEERS.

When, a few months ago, the Benjamin Electric, Ltd. (Brantwood Works, Tariff Road, Tottenham, N.17), issued an interim catalogue of their manufactures, we noted the value and completeness of the information it contained. The complete catalogue of Benjamin Products has now been produced and we can say without hesitation that it meets to the full the requirements of contractors and engineers engaged in the all-important question of industrial illumination on which we need not here dilate.

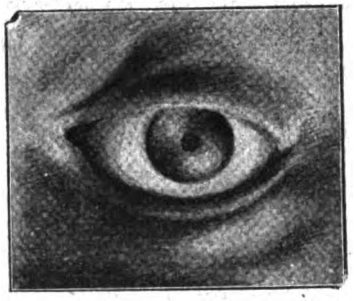


FIG. 1.

The publication is on the loose-leaf principle and is divided into sections readily marked off one from the other. Section I. deals with the requirements of correct industrial lighting, treating of the necessity of avoiding glare, providing a sufficient intensity of illumination, proper direction of light rays, good diffusion, steady light sources, proper intensity on walls and ceilings, and the attainment of simplicity, reliability and economy. We reproduce in Fig. 1 a photograph showing the pupil of the eye contracted under excessive glare and shutting out light, thereby impairing the

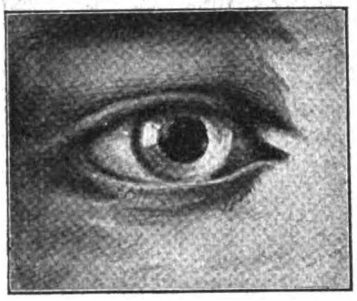


FIG. 2.

sight, and in Fig. 2 a photograph of the same pupil expanded and letting in the amount of light necessary for correct vision. Passing on, the four types of lighting used in industrial plants are considered in detail—the four types are (i.) general, (ii.) localised, (iii.) combined general and localised, and (iv.) modified general lighting. Under the heading of general illumination data, there are several pages of information, including tables and graphs on height and spacing of light units of different sizes and with different fittings, of great use to contractors and engineers. The foot candle intensity necessary in various industries is also given, as well as general reference tables and information.

When we come to the lighting fittings themselves, we find them amply illustrated and described, characteristic distribution curves being given where necessary, and dimensions and prices included. From such a collection of fittings as are made by the Benjamin Co., it is difficult to pick out any for special reference, but the "Anti-glare" Biflector fittings for interior or exterior use with gasfilled lamps might be referred to. The "distributing" type is seen in Fig. 3, and is particularly suitable for low-ceiling workshops, railway station platforms, shop lighting, etc.

Section II. is devoted to outside lanterns and well-glass fittings, Section III. to various lighting devices, Section IV. to shop-window lighting specialities, Section V. to industrial signals for high voltage A.C. or D.C., Section VI. to



FIG. 3.

automobile accessories, and Section VII. to accessories and spare parts for Benjamin Specialities. A catalogue number index completes the catalogue, which is a most commendable publication.

RELIABILITY OF AUTOMATIC TELEPHONE EQUIPMENT.

An interesting report on an experiment carried out by the Automatic Electric Company in order to compare the wearing qualities of the brass punchings that go to make up the contact bank if a Strowger switch with similar punchings made from a newly developed alloy, is quoted in the last issue of the *Automatic Telephone*. To perform this experiment a contact bank was constructed having one level of standard brass contacts and another level of contacts of the new alloy. Each of the two levels was fitted with a set of standard brass wiper springs mounted in such a way that one upward step of the shaft would bring each wiper opposite its corresponding level.

A circuit was then arranged to operate so that the shaft made one vertical step, rotated the wipers over ten of the contacts of their respective levels, and then released, the operation being repeated continuously for a period of several weeks. A meter was wired in the circuit for the purpose of counting the number of operations. When the meter had registered a total of 400,000 calls, the bank was removed for inspection. Without going into the comparative durability of the materials under test, the condition of the level of standard brass contacts revealed some interesting facts. These contacts were found to have been worn not quite half-way through. When it is considered that the spring tension of the wipers diminished as the wear on the contacts increased, the indications were that the contacts could have withstood at least twice as many operations, or a total of 800,000, before deteriorating to the point where good service was no longer possible.

These operations took effect on one level of contacts only, whereas in a connector switch, for example, the total number of calls would be distributed fairly evenly over all ten levels, i.e., the test indicated that a connector bank should be able to withstand the wear incident to the making of 8,000,000 calls. Assuming that a connector switch carries traffic amounting to an average of 100 to 140 calls per day, a connector bank would be capable of withstanding, roughly, from 150 to 200 years of actual service.

If the bank is mounted on a first selector switch, it will, of course, wear somewhat faster due to the fact that

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first selectors ordinarily operate at a somewhat higher efficiency and the fact that very often some of the levels are "dead," that is, they carry no traffic. Assuming an extreme condition where the majority of the traffic works from, say, two levels of the first selectors, and assuming that each selector will carry from 150 to 200 calls per day, the data furnished by the experiment would indicate the useful life of the selector bank to be approximately from 33 to 44 years.

It is further added that the test apparatus was made of standard materials drawn from the factory, and that practically no attention was given while the test was on.

PILWRLWYD DEMONSTRATION FARM.

The Pilwrlwyd Agricultural Institute and Demonstration Farm, which was purchased by the Carmarthenshire County Agricultural Committee for £18,000, is being brought up-to-date by a further expenditure of £3,000. The question of either installing a generating plant, or of purchasing electricity from the Carmarthen system, has been considered and it has been decided to install an oil-engine set. It is now urged that electricity should be used at the Institute for the improvement of crops, etc.

It is interesting to note some of the arguments used concerning the merits of the proposed systems of electricity supply:—

The architect thought it would be better to get the supply from the town, and this, he estimated, would cost about £600. Their own installation would cost about £500 to put in. Mr. Ll. Griffiths (Toulon) said farms of the future would have electricity installed in them, and in an institute where young men were to be educated in farming, the students should certainly be taught the way to deal with electric plant so that they might know what to do when on their own farms if something went wrong with it. Mr. Davies (Pistyllgwyn) said many farmers in the county were thinking of going in for electric light on their farms, at it was a very important part of the education of farmer's sons to have practical experience in the working of it at their institute. Pilwrlwyd might teach them more in this respect than in any other phase of farming.

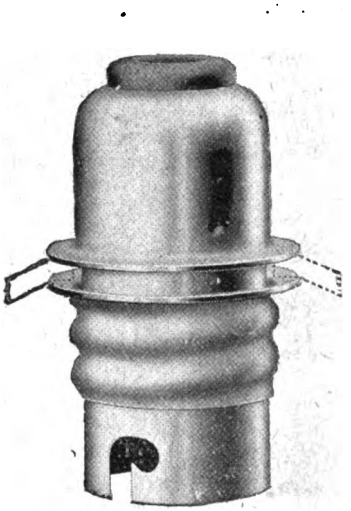
BRITISH INDUSTRIES FAIRS.

The report of a Committee appointed by the Board of Trade to consider the best policy to be adopted in future as regards British Industries Fairs is welcome, in that it suggests that the Department responsible does not intend to allow itself to get into a groove." For the past two years the Fairs, which were inaugurated during the war, have been held simultaneously in London, Birmingham and Glasgow, and the electrical interest for the most part has been concentrated in the Birmingham Fair, to which was allocated electric light fittings and apparatus, which really constituted the sole electrical side of all three Fairs.

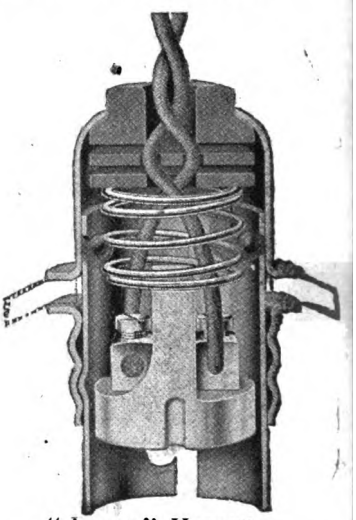
Suggestions have been made, however, for widening the scope of the Fairs, and among them is that electric hoisting appliances, cranes, elevators, etc., and lamps, should be added to the London Fair, and not be confined exclusively to the Birmingham Fair. The Committee is of the opinion that the Glasgow Fair should be abandoned, owing to the lack of support which it has received, and although it is in favour of there being only one fair, and that in London, it gives way to the strong feeling in Birmingham that one should continue to be held there, and suggests that the exhibits hitherto accommodated in Glasgow should be transferred either to Birmingham or London. The Committee also favours the view that the scope of the Fairs should be extended in the directions indicated, and in the absence of any suggestions for a comprehensive electrical exhibition in the near future, it would not seem to be at all a bad plan to include as many electrical exhibits as possible, both in London and Birmingham. At the same time, one cannot help feeling that it would be a good thing if, at any rate, the leading industries of the country were to take in hand this question of exhibitions, and handle it in a more lively spirit than has hitherto been shown. It is many years since the electrical industry had an exhibition, and the period since the last one has, of course, been unduly extended owing to the war, but there is little doubt that regular exhibitions do serve to keep the progress of industries before the public notice. We have only to look at the annual motor-car and commercial vehicle exhibitions to prove this. We know that the Electrical Department Association is carrying out its propaganda work most effectively, but it can hardly be denied that the general publicity which would be given to a big electrical exhibition would be all to the good if such an exhibition took place at regular intervals. It would then only be necessary for the Board of Trade Fairs to deal with those smaller trades which are not, perhaps, sufficiently large to warrant holding individual exhibitions of their own under the auspices of their particular trade associations.

THE "LESCO" LAMPHOLDER.

The "Lesco" lampholder, described in ELECTRICITY for Jan. 30th, 1920, has been improved, and the 1921 model is designed for the fixing of shades in the orthodox way, excepting that a coarse rolled thread replaces the usual fine thread, so that the operation of fitting or removing a shade is quickly effected. Combined with the description previously given, the illustrations herewith explain the construction of the 1921 "Lesco," which is guaranteed to carry 10 amps. The cord-grip will sustain a pull of 50 lb., needs no cutting away and will take any size flex up to 70-40.



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E.T.U. Conference.—Seventy delegates from all parts of the country attended a special conference of the Electrical Trades Union at Blackpool last week. Mr. J. W. Ball, of Manchester, the president, has occupied the chair. The fact that several thousands of members are on strike against wage reduction added special importance to the proceedings. The meetings were private. Following the presidential address the conference approved of the principle of amalgamating with other trades unions. Reports were given as to the position of the strike all over the country.

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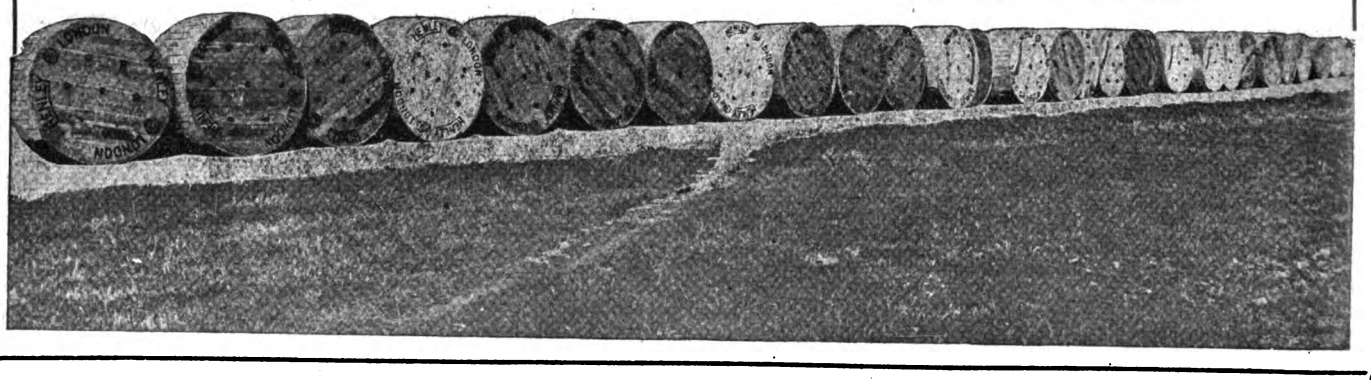
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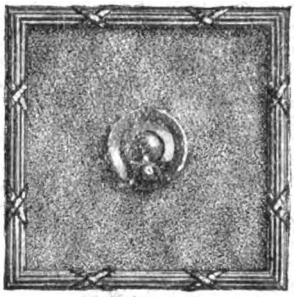
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application.

Subscription.—17s. 6d. a year, 8s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Oil to the Rescue.

Those firms which specialise in oil-burning equipment for steam-raising plants must be enjoying a boom as the outcome of the miners' holiday. Although admittedly somewhat dearer than coal per gallon of water evaporated, the liquid fuel nevertheless functions well in such emergencies as the present, and there is little doubt that the engineers of the more enterprising power stations will retain their oil-burning installations long after the coal difficulty has been settled. It renders them independent of the coal difficulty as and whenever it arises. Barrow, Sunderland, and the Carville Power Station, Wallsend, which supplies Tyneside shipyards, are among the latest devotees of oil fuel, whilst many other power authorities are experimenting and have installations in contemplation if not actually in progress of fitting.

Incidentally, the coal shortage seems to be reacting on tramway undertakings, and one hears most complaints from engineers and managers of these undertakings Having regard to the fact that there are other means of locomotion available, it is difficult to see why the authorities concerned should be so anxious to maintain these services at their full complement, and at the expense of other and more pressing demands for electrical power in factories and for lighting. When all is said and done the populations of most industrial centres have become so accustomed to tramway deficiency during the war years that it is no novelty to have half the service lopped off for a week or two and let some of the lazier short-distance travellers take a bit of useful and healthy exercise.

In actual practice it is almost as big a drain on the power station to run a restricted service of trams as to adhere to the full time-table. The saving in current is not directly proportional to the reduction in car services, or anything like it, and on common-sense grounds it would appear preferable to keep certain factories running on full time where circumstances permit rather than aim at carrying a greater proportion of the population on errands many of which could well be accomplished by walking. So far as the holiday traffic was concerned, the problem was very effectually solved with the aid of petrol and push-bike. The roads were thronged with motor vehicles of every description, most of them grievously overloaded, whilst I have never seen so many push-bikes in evidence since the old days when cycling was at its zenith. Truly the indications are that coal and the railways have had their day, and that necessity is rapidly furnishing substitutes.

The Pampered Pig.

When Pontypridd Board of Guardians rejected a recommendation that electric light be installed at the Board's pigsties a member observed that they would next be asked to appoint a chiropodist, dentist and valet for the animals. It certainly sounds somewhat extraordinary to thus illuminate so humble a structure as a pigsty, but in these days we aim at efficiency everywhere, and there could be no better artificial illuminant if such be indeed necessary. We think nothing of fitting electric light in stables and other farm buildings, so why not in pigsties?

On the Eve of Discovery.

Are our leading physicists mistaken, or is it possible that we are about to discover some epoch-marking principle of liberating the enormous stores of latent energy which are known to exist in various forms of matter? The electronic theory opens up some fascinating possibilities along which many clever brains are at work, and it may be that the next generation will have no miners' strikes simply because the need for coal will have ceased. The familiar principle of the conservation of energy still obtains, but, according to Sir William Bragg, there is a difference when one comes to study the behaviour of ether waves and electrons.

On his showing, when a powerful electric discharge acts on the matter in an X-ray tube, electrons are liberated, moving with a speed of at least 600 miles per second. These electrons do not travel far but rapidly lose speed, and adhere to atoms with which they come in contact. During its passage, however, each electron sets up an etheric wave which travels in every direction, as ripples spread from a pebble thrown into water. As these radiations travel outwards, losing amplitude or energy, they possibly come in contact with matter, in which case they cause the emission from that matter of electrons moving with an energy equivalent to that of the original electrons which produced them. Each radiation is tuned so as to give rise to an electron having the same speed as the original electron.

Illustrating by simple analogy, Sir William Bragg instanced a log of wood, dropped into the sea from a height of 100 feet, and producing a wave or ripple, radiating from the point of impact with the water. As the wave spreads the original energy is more and more widely distributed, and the ripples decrease until they ultimately become invisible. To continue the analogy in its application to recent discoveries, this wave striking a ship at some part of its circumference would cause one of its timbers to fly up in the air to a height of 100 feet. There is no question of the energy displacing this timber having been conveyed by the ripple. Some latent force on the vessel liberated by the ripple, and tuned to its frequency, would have been tapped.

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Much remains to be done before these new discoveries are turned to practical account, but the surface of the problem has been scratched, and, with some of the best brains in the country concentrated on further developments, anything may happen. We have not yet found a way of getting a quart out of a pint pot, or of taking more kilowatts out of a generator than are put into it in the guise of horse power, but we know that these vast stores of energy exist, and, if we can only discover a means of tapping them as when needed, the vital problem is solved.

Electroculture.

This season has been barren so far in the matter of published records of results in the application of electricity as a stimulus to plant growth. Summarising the results of past experiments, it must be admitted that the results obtained hitherto are not very illuminating so far as a proper understanding of the theory of electricity in its effect upon agriculture is concerned. Methods have been crude in the extreme, and a long series of carefully conducted experiments on a properly organised basis would appear necessary to establish some correct method of procedure to obtain the best results. There are so many controlling factors in plant growth; soil, seed, atmosphere, rainfall, sunshine, all contribute to the ultimate result, and to string an electrified network over one plot and claim superior harvests to the plot adjacent due to purely electrical causes cuts no ice. There is ample scope for careful and long-continued research work by some of our agricultural colleges, preferably conducted on individual growths of pot plants which can be subjected as far as is practicable, to identical influences other than electrical.

ELEKTRON.

THE "PARAGON" THERMO-ELECTRIC RAILWAY LOCOMOTIVE SYSTEM AND ITS PRIORITY RIGHTS.

A case which is calculated to be of more than passing interest to the electrical and railway industries, is coming on shortly before the Comptroller General of the British Patent Office for hearing.

It is fairly well known that Captain W. P. Burtnall claims to be the original inventor of the above system of "Self-contained, self-propelled railway locomotives," using polyphase alternating current transmission.

It appears that an attempt is being made to embody the same system in an application for a British Patent (No. 163,870) by Messrs. The Oerlikon Company, of Oerlikon near Zurich, Switzerland, who are proposing to use slip-ring motors coupled in cascade for the driving of the axles of locomotives fitted with a steam turbine as prime power, driving a polyphase alternating current generator, and so being "self-contained and self-propelled." This Captain Burtnall is contesting, on the basis that the use of such a well-known motor is not an inventive step, and has in fact been embodied in many lay-outs for his "Paragan" locomotives during the last 15 years, and he does not see that his well-established system should be saddled with a British Patent in these days, which would compel the use of any other types of motors than those which he is able to buy in the open market to his specifications. Captain Burtnall has already successfully contested the application of the Oerlikon Co. in 1913, for a similar proposition, in connection with his well-known railway system.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 117.

The construction of stone cellular type switchboards is not generally understood. Please can you give me some idea of the contents of a cell for, say, a generator panel? What safety and protective devices are necessary to make the cell foolproof?—"TRANSFORMER."

QUESTION NO. 118.

What is the principle of operation of auto-transformers for starting induction motors? Is this method to be preferred to the ordinary starter, and is it cheaper?—"STATOR."

(Replies to Questions Nos. 117 and 118 must be received not later than May 28, 1921.)

Answers to Questions.

QUESTION NO. 116.

I would appreciate full constructional details of a resistance which is to reduce 100 volts to 80 volts when a current of 5 amperes is passing for an indefinite period. How shall I wind the wire? Will mica or enamelled insulated steel tubes be satisfactory?; and what size and kind of wire is most suitable if the temperature is not to exceed 300 deg. F.? The resistance is to be enclosed in a flame-proof box, and the use of oil, for cooling, is prohibited.—"B."

REPLIES TO QUESTION NO. 116.

The first prize (10s.) has been awarded to "B. L. Y.", for the following reply:—

The total resistance required will be $\frac{100-80}{5} = \frac{20}{5} = 4$ ohms. The resistance wire to be used should preferably have a negligible temperature co-efficient, so as to keep the current at a steady value at all temperatures, and for this "Eureka" wire, manufactured by the London Electric Wire Co., is very satisfactory. The gauge of wire to suit the conditions given will be No. 12, which will attain a final temperature rise of 200 degs. F. with 5 amps. after any length of time if totally enclosed. The writer has found that the following method of construction gives excellent results, no appreciable deterioration having taken place in any cases after 10 years' use, either as regards insulation or fireproof qualities. Use 1-in. diameter Simplex tubing (or if A.C. is being utilised 1-in. brass do.), then with 1-32-in. sheet asbestos cover this sheeting with flake mica, and wind these on tubing, using shellac varnish for binding together. Secure with string and dry in a warm position. This asbestos and mica should be of such a length that when wound on tube the outside diameter is $1\frac{1}{4}$ in. The number of yards required of wire is $\frac{47}{\cdot 0793} = 51$ yards, and if using 7 turns of wire

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per inch of tube the yards of wire on each inch of tube will be ·763. The number of inches of winding required is therefore $\frac{51}{.763} = 67$, and this length can be divided up to suit dimensions of box, allowing on each tube ½ in. at each end for leakage space and fitting suitable clips at ends for connections.

To wind the wire on tube remove string, fix between centres of screw-cutting lathe by mandrels driven in tube ends, and set wheels for 7 threads per inch, guiding the wire on by a hole in steel-piece held in tool-rest. This hole should be slightly larger than the wire, and well rounded both sides, tension being applied as may be found necessary. After winding and fitting clips coat with an insulating enamel to prevent corrosion, and to keep damp-proof. The design of clips and method of fixing tubes in box must be left to the design of the box, etc.—"B. L. Y."

The second prize (5s.) has been awarded to "M. M." for the following reply:—

To reduce the 100 v. to 80 v. with a current of 5 amps. we have: $R = \frac{E}{I} = \frac{100-80}{5} = \frac{20}{5} = 4$ ohms. For this resistance use No. 16 manganin wire; about 37.7 yards will be required. Wind in a helix having a diameter of about ·75 inch. Divide up in eleven coils of about 1 ft. 1 in. in length. Place coils in a sheet iron box of dimensions 1 ft. 1 in. × 7 in. × 5.5 in. (inside measurements). Arrange helices in two rows of four and one of three. Halfway up box fix a separator of uralite; the uralite to have eleven holes through which pass the helices. Fill up box with sand.

Terminals on outside of box to have protecting caps, and the connecting leads to have a fireproof covering. —"M M."

Correspondence.

50,000,000 TONS OF COAL WASTED.

To the Editor of ELECTRICITY.

SIR.—Through the community ignoring the utilisation of all the available water-power in this country, the above is the amount of coal annually wasted. This may appear exaggerated, in reality it is under-estimated.

For instance, the coal strike has caused the loss of 4,800 tons of coal on the Manchester Ship Canal, by greatly reducing traffic, thereby the stagnant state of the locks has caused a correspondingly heavy flowage through the sluices, if this had been efficiently harnessed it would to a large extent have compensated for reduced tolls.

If this important waterway in normal times was made the best use of as regards power possibilities, the saving of coal would be 30,000 to 50,000 tons yearly.

In the face of these facts Manchester and Salford are now erecting on the principal water course two super-generating stations to use the water not for power but for condensing, for which purpose the value is only a fraction of what it would be for hydraulic power producing. To properly keep these two monster coal-eating plants going will require, at a conservative estimate, 250,000 tons of coal yearly.

Now within a 12 mile area of Manchester, I know of 17 mills which were run by water-power when coal was 10s. and under, now it is over 30s. the ton not one is working. Considering this is in a highly industrial centre, where coal is speedily becoming exhausted, this is deplorable, as it helps to place the miner top dog to punish us.

Again, this country used to be the cheapest coal producing country in the world, now it is the dearest of all coal producing countries, yet we still persist in ignoring fundamental economic laws, by studiously neglecting our water-powers, whereas other countries (see foreign notes in any engineering publication), with far cheaper coal, are developing water-power at a feverish speed. No wonder we are heavily taxed and losing trade.

If this coal dispute does not make water-power duly valued, nothing will.

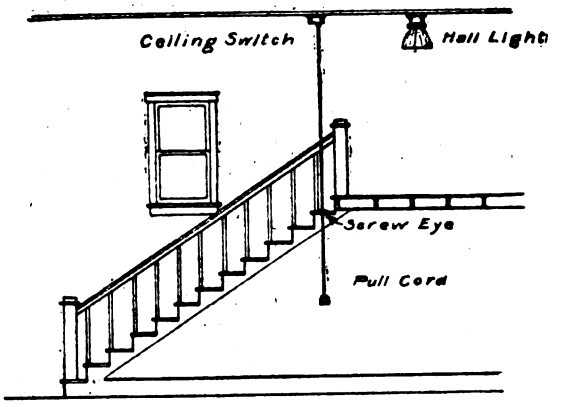
W. ANTROBUS.
Hydro-Electrical Engineer.

Lawrence St., Eccles, Manchester.

SUBSTITUTE FOR A SET OF THREE-WAY SWITCHES.*

BY H. S. RUSH.

One of the most useful switch control features which can be used in the residence wiring job is the three-way switch control for the upstairs hall light from two points, one upstairs and one downstairs. In the small residence these convenient switches are often omitted as an expense which cannot be afforded. At a small



Single Pull Switch Mounted to Work From Two Floors.

cost many of the advantages of a set of three-way switches can be secured by placing the upstairs hall light on a ceiling pull-cord switch so placed that the cord may be conveniently reached both upstairs and downstairs. Where the cord cannot be dropped directly from the second floor ceiling to the first floor the cord can often be carried along the wall of the stairway, using small screw eyes as guides.

Trade Notes.

In Installation Leaflet No. P 2,463 **The General Electric Co., Ltd.** (Magnet House, Kingsway, W.C.2), illustrate and describe the gas-engine plant installed at Wiseton Hall, Bawtry, Yorks, the residence of Brig.-Gen. Sir J. F. Laycock, for the electrical requirements. There are two generating units, totalling 120 h.p. National gas-engines running off suction gas and "Witton" 230-300 volt. generators and a battery of 122 Tudor L.Q. 15-type cells of 800 amp.-hr. capacity at the 10-hr. rate.

The General Electric Co., Ltd., has now issued a leaflet (No. F. 2481) on the directive system of street lighting (Longitudinal Lighting Lanterns—Haydn T. Harrison Patents). The principles of operation are briefly described, aided by a clear, useful sectional diagram and other illustrations of lanterns for main and side streets.

Blackpool.—A similar fuel plant has been adopted in the electricity works to that in use at Blackburn, 80 per cent. oil and 20 per cent. coal being used. The Blackburn plant was installed, and large reserves of oil purchased last October. Augmented steaming capacity is obtained, and the coal more efficiently used.

* *Electrical Review*, Chicago.

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THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

By Sir William Noble, M.I.E.E.

(*Continued from page 282.*)

It was decided to proceed with the London-Manchester development on these lines, and at the time of writing this paper the duct route between the terminal stations has been completed and the cable is well on the way. Duct space has been provided to take care of developments for the next 20 years. The duct route forks at Derby, one route going north to Leeds and the other north-west to Manchester (see Fig. 14). The repeater stations will be located at Northampton and Derby, and, as new buildings are required and cannot be completed and equipped to be ready for the completion of the cable, a temporary repeater installation is being provided in an existing Post Office building at Leicester, with sufficient equipment to operate the number of circuits required for two years ahead. The circuits will be worked temporarily at a rather lower efficiency than that designed for the full scheme, but they will be equal to most of the existing aerial lines and will relieve the present congestion on the routes between London and Lancashire and Yorkshire. In addition to this, the risks of interruption of service by storms will be minimised. A floor plan of a telephone repeater station is shown in Fig. 15.

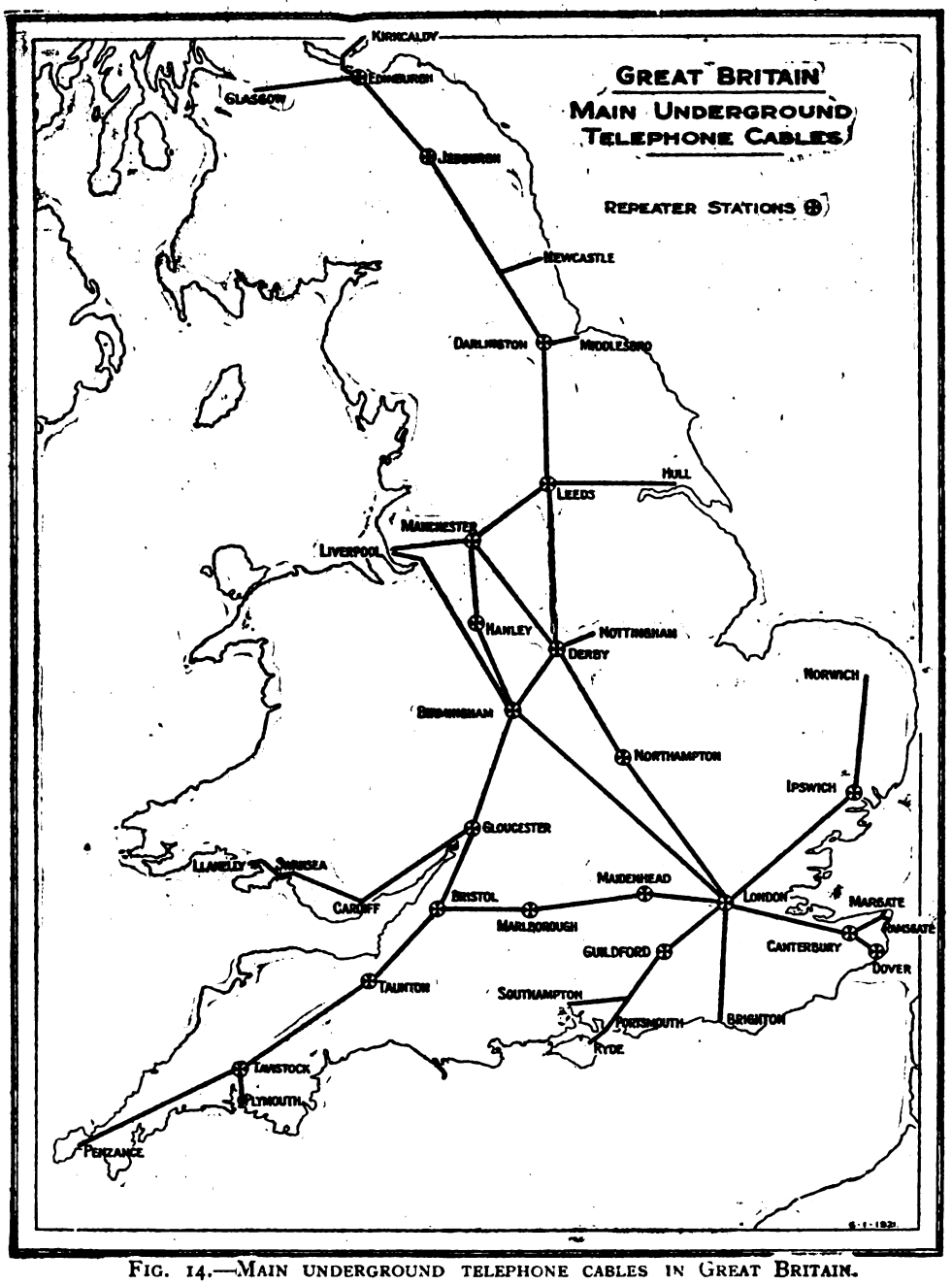


FIG. 14.—MAIN UNDERGROUND TELEPHONE CABLES IN GREAT BRITAIN.

At the present time the construction of similar main cable routes from London to Southampton and Portsmouth and from London to Bristol and the west has been commenced. In due course the northern cable route will be extended beyond Leeds through Newcastle and Edinburgh to Glasgow, so that in the course of a few years all main

* Paper read recently before the Inst.E.E.

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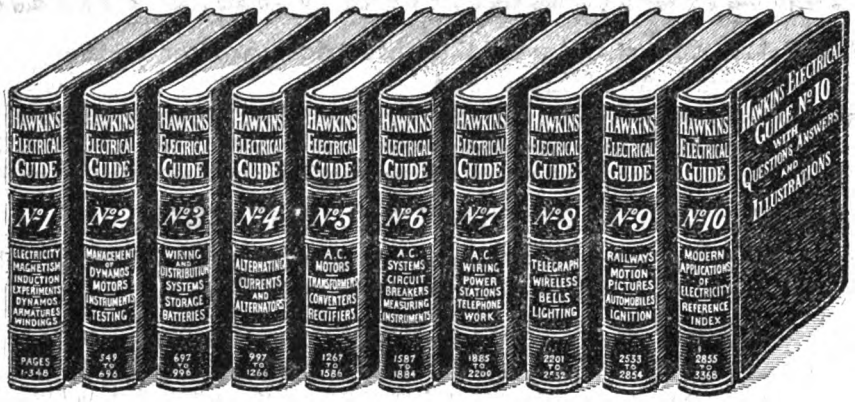
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telephone communications between the important commercial centres of the country will be underground, giving a quality and stability of service which will be equal to, if not better than, any in the world.

SUBMARINE CABLE DEVELOPMENT.

The pioneer work performed by Post Office engineers in the development and introduction of gutta-percha covered cables will be evident from the paper by Colonel O'Meara already referred to. Since that time the subject has received continuous attention both by the Post Office engineers and British cable manufacturers, who have always been in the van of progress in regard to submarine cables. In 1911 Messrs. Siemens Bros. and Co. introduced a form of balata dielectric as a substitute for gutta-percha in loaded submarine cables, on account of the greatly reduced leakance of the former as compared with the latter. The effect of this improvement was to reduce materially the attenuation constant and increase the range of speech in loaded cables.

In 1914 the Post Office engineers called attention to the fact that it is possible to obtain four circuits from a loaded four-wire submarine cable if the circuits are isolated from the land lines at the ends of the cable by transformers, viz., the usual two side circuits and one loop phantom circuit, the fourth circuit being obtained by using the four wires of the cable in parallel with earth. Experiment shows that the fourth circuit can be made successful in a continuously-loaded cable, but it has not yet been successful in a coil-loaded cable.

In certain circumstances where a four-wire loaded cable could not be satisfactorily laid owing to the weight of the cable, it might be desirable to lay single-wire loaded cables, and an investigation of the electrical constants which might be expected in such a cable has been made by the Post Office. It is found that the effective resistance of the conductor in such a cable would be materially greater than that of half the resistance of a loop circuit of the same gauge, and experiment shows that, when tested at a frequency of 800 periods per second, the resistance is approximately 2.5 ohms more than that of the resistance of the same single wire when measured by direct current. The increase of resistance was found to be the same for conductors weighing 500 lb. per nautical mile per wire and 100 lb. per nautical mile per wire. The increased resistance in the two cases is due to the effect of the cable sheath and

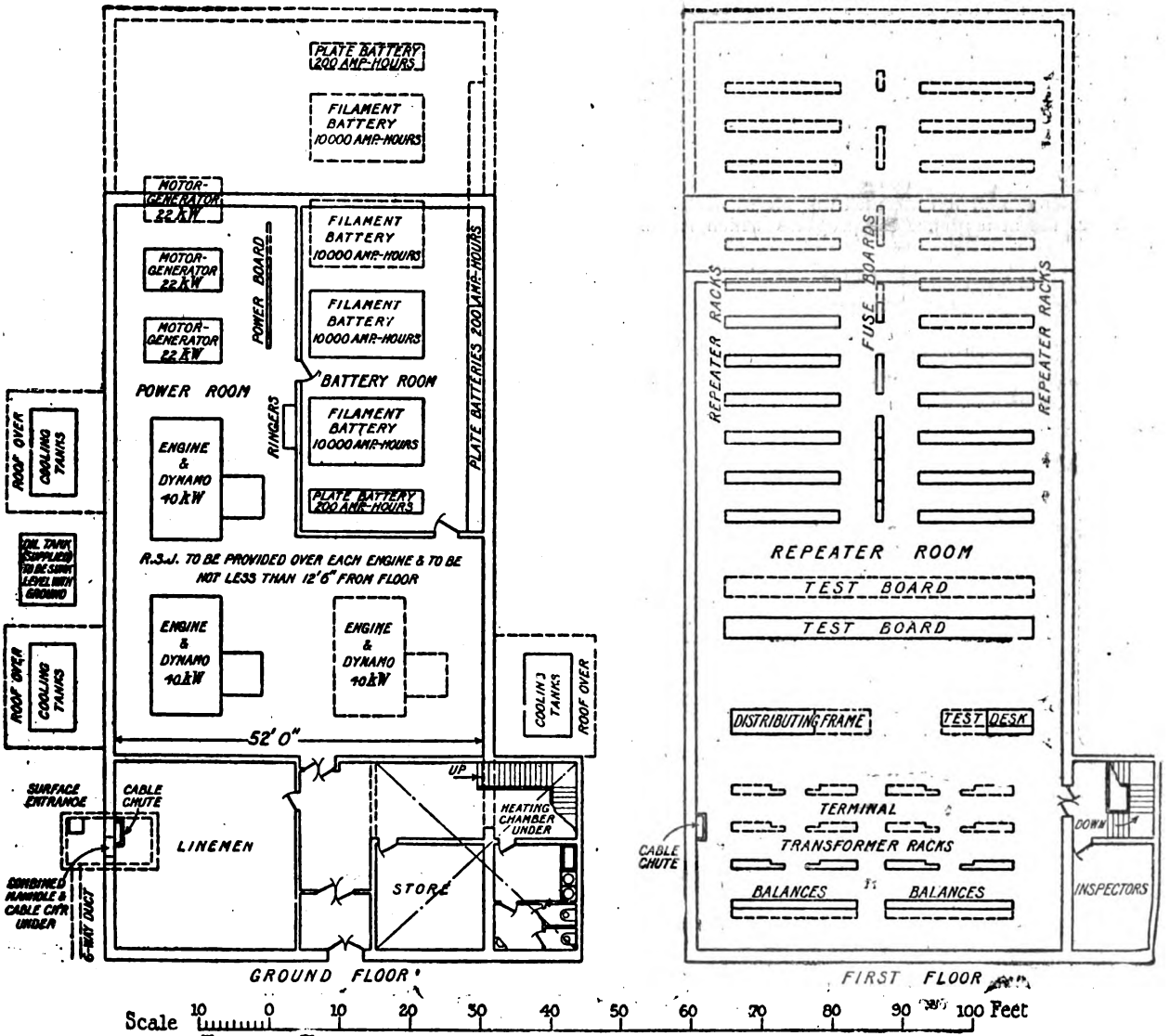


FIG. 15.—TELEPHONE REPEATER STATION: PROPOSED ARRANGEMENT OF PLANT.
The broken lines represent the ultimate building.

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the return path consisting of sea water, and these are similar in the two cases.

The usual type of submarine cable contains four wires, but where it is necessary to carry a large number of circuits across a wide river or estuary four-wire cables are unsuitable. To meet this requirement a continuously-loaded cable has recently been designed and is now being manufactured for the Post Office. This cable will contain seven quads, and it is hoped that seven phantom circuits will be obtained in addition to the 14 side circuits. The weight of the conductors is 70 lb. per nautical mile per wire, and of the dielectric 110 lb. per nautical mile per wire. The attenuation constant of the cable circuits for speech purposes is 0.05 per nautical mile, which is practically the same as that of the unloaded telephone submarine cable conductors weighing 160 lb. per nautical mile per wire and insulated by gutta-percha weighing 300 lb. per nautical mile per wire. This cable was the standard type for long-distance communication before the advent of loading, and it contained only four wires. This enables us to see at a glance the progress which has been made.

The introduction of telephone relays has made it possible frequently to use submarine cables of a less efficiency than the coil-loaded cables previously required. This makes it practicable to increase the use of continuously-loaded cables in which the difficulties of maintaining loading coils in submarine cables are entirely eliminated.

The present policy is, on this account, to extend materially the use of submarine continuously-loaded cables

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

DYNAMO AND MOTOR ERECTION AND MANAGEMENT. By A. H. Avery. (Cassell. 1s. 6d. net.)—This is practically a reprint of a series of articles which have already appeared in the columns of our contemporary *Work*, and in its book form will appeal to a large number of amateur readers of that paper. It covers quite a large amount of ground and will, we are sure, find a ready sale among those for whom it is intended. Needless to say, the publication is a credit to the house from which it emanates.

ARTIFICIAL LIGHT. By M. Luckiesh. 366 pp., 41 illustrations. (University of London Press. Published by Hodder and Stoughton, 12s. 6d. net.)—Written for the general reader and not the lighting expert, there is much of interest and value recorded. The treatment is historical, the earlier chapters dealing particularly with primitive artificial light, Chapter IV., "The Ceremonial Use of Light," being of very considerable interest. The early history of gas, arc and incandescent filament electric lamps are among the subjects later dealt with, while Chapter XVI., "The Cost of Light," although the figures given are in dollars, lucidly shows the progress made in recent years towards the goal of cheap and plentiful artificial illumination for street, office, factory and home. The author is most enthusiastic about the progress already made and what will no doubt be made in the future, and while we are very largely with him, we cannot look forward with much joy to the happy years ahead when buildings will be erected without windows to save space and reduce cost! The Americans have developed spectacular lighting much more than we have, and the great importance attached to it and artistic effects generally, might with advantage be read by many. On the face of it, this kind of thing appears an expensive concession to primitive instincts, but careful consideration leads one to the conclusion that there is something in it which should tend to cheer up our proverbial doleful outlook. "Artificial Light" is a book well worth reading. The chapters need not be read through from cover to cover consecutively, but the whole is certainly instructive and more illuminating than many novels and collections of short stories.



Various Items.

Overalls.—Readers who wish to purchase overalls should study the advertisement of Messrs. Currey, of Manchester, in the prepaid columns.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 27th inst., at Caxton Hall, at 8 p.m. Lecturette: "Notes on Electrical Transformer Breakdowns," by S. A. Stigant (Member). Slides.

Fire.—Damage estimated at £5,000 was caused by a fire at the works of Messrs. F. W. Birkett and Sons, brass founders and finishers and electrical engineers, at Cleckheaton.

Business in Greece and Spain.—The Commercial Secs. to H.M. Legations at Athens and Madrid are on a visit to this country and will be pleased to meet manufacturers and merchants concerning the state of trade, etc.

Mid-Lancs. Electy. Dist.—A further extension of the time within which objections or representations concerning the proposed district may be made to the Electricity Commissioners has been made. The latest date now is July 30.

The "Universal" Washer and Wringer.—The British selling agents for the "Universal" Washer and Wringer, which was illustrated and described in our issue for May 13, are L. G. Hawkins and Co., 114-116, Charing Cross Road, W.C. 2.

Personal.—Mr. Louis H. Euler has been appointed joint managing director of the Saxonia Electrical Wire Co., Ltd., Greenwich, manufacturers of flexible wires and cables. Mr. Francis S. Thomas, the founder of the Company, still continues chairman and managing director.

A Large Lamp Contract.—The half-yearly contract for the supply of metal, gasfilled and carbon filament lamps to H.M. Office of Works has been secured by the G.E.C., Ltd., of Magnet House, Kingsway, London, W.C.2. This important contract runs into many thousands of lamps, and the fact that it has been again passed to the General Electric Company is the strongest possible testimony to "Osram" quality and service.

Electricians' Dispute.—At a conference of the Electrical Trades Union at Blackpool, on May 19, Mr. Tom Mann gave an address on the question of affiliating with the Third International. At the delegate conference the executive were instructed to open up negotiations with the employers with a view to a settlement of the various disputes. The men were recommended to resume their work in the different centres.

Standardisation.—A conference was recently convened by the Brit. Engng. Standards Assoc. of the secretaries of the various "Standardising" organisations in existence. The following countries were represented:—U.S.A., Norway, Holland, Canada, Belgium, Switzerland, and Great Britain. The conference had no executive functions, but ideas were exchanged on the question of the establishment of closer relationships. It appears to be now recognised that industrial standardisation, whether of quality or dimensions, to be really useful, must be arrived at through a process of unifying the needs of industry rather than by attempting to set up an ideal. It also appears that whereas engineers are everywhere giving freely of their time and experience to this important work, its value to commerce generally is far too little appreciated, and is, therefore, not being supported financially to the extent it should be.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
JUNE 3, 1921.

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THE LIGHTING OF FOOD SHOPS.

Light and food are traditionally and intimately related. The lavish feast and the frugal chop are equally improved by the appetising influence of light. Throughout the ages this connection has been recognised by the followers of Epicurus. Lucullus, no less than Pickwick, was blissfully aware of the gastronomic value of meal-time illumination.

Once admit that good light is necessary for the proper enjoyment of food, that it makes the dishes look more attractive, and the corollary proposition that good lighting will also enhance the appearance of food displayed in a shop becomes irresistible.

MacFisheries, Ltd., are among those who have already appreciated the logic of this argument, their shops being illuminated with a brilliant, evenly diffused light, which makes the fish and poultry look far more tempting than is sometimes the case in similar establishments. Further, by good display and scrupulous cleanliness, which, without good lighting cannot be properly appreciated at night, extra valuable publicity is afforded.

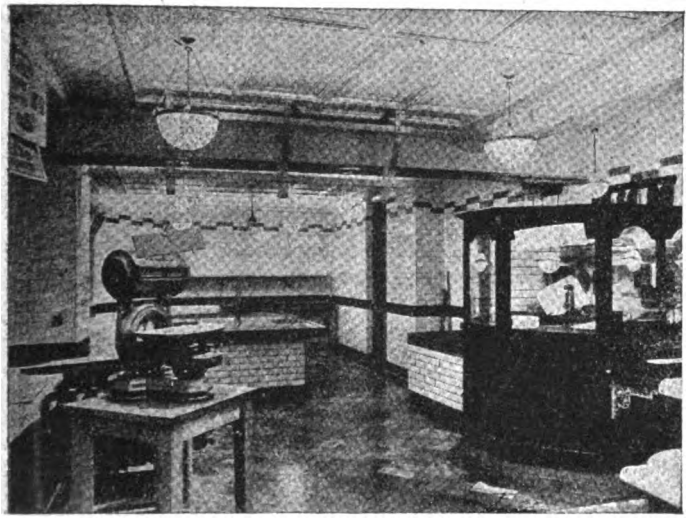


FIG. 1.—NIGHT VIEW OF INTERIOR OF MACFISHERIES' RUGBY SHOP.

No doubt the proprietor of a badly-lighted shop derives some personal satisfaction from the cleanliness of his premises and the freshness of his stock, but if he desires these virtues to be publicly acknowledged and financially rewarded, he must provide the kind of lighting necessary for their proper appreciation. It is difficult to keep a dark shop clean, and still more difficult to persuade people that it is clean, whereas good lighting facilitates both performance and belief.

The illustrations are of the Rugby branch of MacFisheries, Ltd., and the lighting scheme was carried out with materials supplied by the British Thomson-Houston Company. Semi-indirect fittings, equipped with opal glass bowls and Mazda gasfilled lamps are used in the interior of the shop. The fittings are spaced to ensure a uniform illumination, while the bowls are sufficiently dense to prevent glare.

As may be seen from the illustrations, which are reproduced from untouched photographs taken by the unaided light of the Mazda installation, the illumination on the counters and on the walls and other vertical surfaces is brilliant without being blatant or in any way obtrusive. A similar degree of brilliance with unshaded lamps, or with an ordinary direct lighting system, would have been accompanied by a great deal of unpleasant glare. In a photograph this would have produced the phenomenon

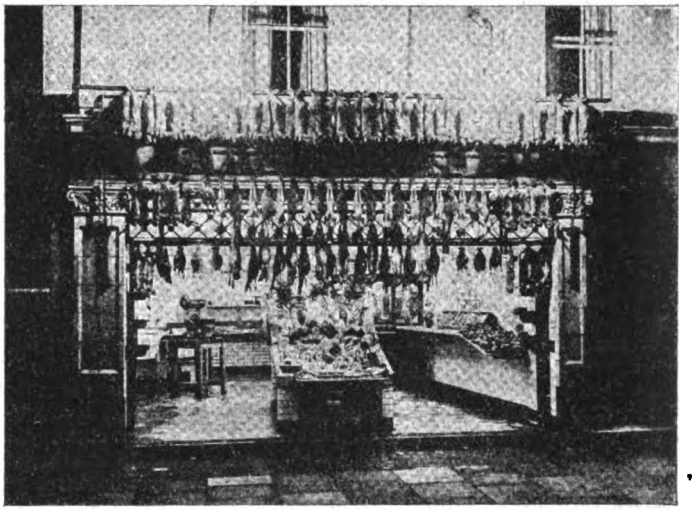


FIG. 2.—NIGHT VIEW OF EXTERIOR OF MACFISHERIES' SHOP.

known as halation, and the details of the fittings and of certain portions of the display would have been obscured to the point of invisibility.

MacFisheries have followed the pleasant and alluring custom, most common to poulterers and butchers, of hanging a considerable proportion of their stock outside the shop. This practice necessitates some form of exterior lighting. In the present installation this is carried out very effectively by means of two B.T.H. "Globa" weatherproof lanterns, suspended from brackets fixed above the fascia, and equipped with high candle-power Mazda gasfilled lamps.

Altogether this installation affords an interesting example of the application of modern methods of lighting to small retail shops. Such a system as the one described is economical in first cost, operation and maintenance, and at the same time is highly attractive and effective in its results. It is suitable for almost any kind of light-coloured interior, although, of course, such details as spacing, height of suspension, and size of lamps might require modification.

Further information on the lighting of food and other shops may be obtained from the British Thomson-Houston Company's Illuminating Engineers, at Rugby, and 77, Upper Thames Street, London, E.C.4.

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THE INSTITUTION OF ELECTRICAL ENGINEERS.

WONDERFUL LECTURE AT FIRST MEETING IN OWN HOME SINCE THE WAR.

Last week was important in the history of the Inst. E.E., as during it, on the invitation of the Council, leading Dutch engineers paid a return visit to this country to inspect various large generating and manufacturing organisations, and to enjoy British hospitality. Further, on Thursday, the first meeting in their own home on Victoria Embankment since its surrender to its owners by the Government took place. Although not yet quite renovated, it will not be long before it is complete in all details. The meeting itself was out of the ordinary in that by the efforts of the President and Council, particularly Mr. Frank Gill, a new physical phenomenon and its application to telegraphy and telephony was demonstrated by its discoverers—two Danish engineers, Messrs. Alfred Johnsen and Knud Rahbek. The packed audience evidenced much interest and expressed heartily their appreciation of the explanation of the phenomenon discovered and its adaptation to commercial purposes, which has been wonderfully rapid since the original discovery only in 1917, when, as the lecturers explained, they discovered that strong adhesive forces were developed in some cases where an electric potential difference was applied to a solid body consisting of certain badly conducting materials, i.e., various minerals, and a conducting body, such as a metal disc, resting on the former body. This adhesion was found to be proportional to the true area of contact between the bodies, so that ground and polished surfaces fitting accurately together afforded the best results.

It was found that the adhesion was due to an extraordinarily strong electrostatic attraction between the two surfaces in contact. The solid materials in question conduct electrolytically and show a very high contact-resistance with regard to an adjacent conductor, if no conducting liquid, cement, etc., be interposed between the two surfaces. The contact resistance can greatly exceed the interior resistance of the material used. If a potential difference be applied to the metal disc and a metal electrode cemented to the semi-conductor (as the material may be called) a weak current will flow through this semi-conductor and across the contact surface to the metal disc. This causes a finite potential difference between the surfaces in contact, due to the very high contact-resistance. The result is an unusually strong static attraction, which may easily be understood if it is borne in mind that the attraction between the plates of an "air condenser" for a given potential difference between the plates is proportional to the inverse square of the distance between the plates. The distance between the attracting surfaces being, theoretically, in this case zero, an infinitely large attraction is manifested, the limitation being probably due both to electrolytic phenomena and to ionization; nevertheless, an exceedingly strong attraction can be obtained at moderate potentials. It has been found that an electrostatic attraction of several pounds can be obtained between a thick lithographic stone, fitted with an electrode at the back, and a metal disc, two inches in diameter, resting thereon, when a potential of 440 volts is applied. The current is of the value of a few micro-amperes. The disc will lift the stone in an exactly similar manner to that in which an electromagnet can be lifted with its armature, and the stone will drop if the current be interrupted. Similar qualities are exhibited by flint, agate, some species of slate and many other minerals and salts, as well as many organic substances, for instance, animal membranes, skin, gelatine, bone, etc. On the other hand, the experiment cannot be carried out with true insulators, such as glass, mica, hard rubber, etc., as the necessary current cannot flow.

The attraction naturally causes a considerable friction between the two surfaces. This is utilised for technical purposes by using the semi-conductor in the form of a cylinder, which is kept in rotation, and onwhich a metal band slides. As soon as a suitable potential is applied to the apparatus the band will adhere firmly to the cylinder and can be made to operate various devices, the whole forming an effective electrostatic relay. In connection with telegraph apparatus, it is essentially useful as a radio recorder, the current from ordinary small valves being sufficient for its operation at a speed up to several hundred words per minute, if a sufficiently high potential (100 to 200 volts) be used for the valves. If the metal band be connected to a diaphragm or similar sound-reproducer, and telephone currents be applied, a very loud-speaking telephone is obtained. This and other applications, including a low-tension pocket electroscope, were demonstrated at the lecture. [This was referred to by a certain daily paper claiming a certain circulation as a wireless receiving set.] One demonstration was the utilisation of a violin to reproduce a violin solo played in another room, where was situated a telephone transmitter, and also its utilisation as a loud-speaking telephone for reproducing the human voice. Excellent reproductions were afforded in both cases.

It is obvious that the phenomenon forms a wide basis for scientific investigation, and that it will probably in the future be used for the construction of electrical apparatus for various purposes, especially in cases where a small current consumption is essential.

ANNUAL GENERAL MEETING AND THE CHARTER.

On Tuesday the Annual General Meeting took place, there being an unusually large attendance. The Report and Statement of Accounts, revealing a particularly active year were adopted without comment. It is interesting to note that the membership now approached 10,000, that the "Institution" Premium has been awarded to Mr. E. A. Watson for his Paper on Magnetos, that as soon as the renovations are complete the experiment is to be tried of keeping the library open on certain evenings to meet the expressed desire of some members, and that the most active committee is the Power Lines Committee. Reference was also made by the President to the E.D.A. being firmly established. There are now 496 members and subscribers and it is worthy of much greater support.

Following this meeting there was a special general meeting, which gave unanimous approval to the proposal to apply for a Royal Charter. This Charter is a modest affair, but will do to go on with. If granted, as we all hope it will be, the Inst. will receive increased status as, instead of being "self appointed" it will be State appointed. That it is wanted by the body of members is evidenced by the fact that in a postcard vote (the postcards were only sent out a week or so ago) 64 per cent. have already been returned and all are in favour except three (not three per cent.). An important power sought is to enable corporate members to designate themselves "Charted Electrical Engineers," thereby establishing their status and preventing "pirating."

Meetings Cancelled.—It is announced by the Secretary that owing to the continuance of the coal stoppage the Scottish Committee have been reluctantly compelled to cancel the proposed Summer Meeting of the Inst.E.E.—The Annual Convention of the Incorporated Municipal Electrical Association which was to be held in Dundee has been abandoned for the same reason.

Ireland.—The report of the committee on Ireland's water resources, which has just been issued, says that about 500,000 water h.p. is available continuously, and can be economically developed in Ireland. The water power is equivalent to that generated in coalfield stations by the annual consumption of more than 7,500,000 tons of coal on the basis of 51 lb. of coal per h.p. per hour, which is the figure taken by the Coal Conservation Sub-committee as the average practice in the U.K. The value of this water-power, if developed, it is stated, would be at least £10,000,000 per annum. Detailed schemes for the development of the Lower Bann, the Lower Shannon, the Lower Erne, and the Liffey are suggested, and the committee regards the Boyne, the Strule, the Mourne, the Lee, the Boyle, the Corrib, and the Blackwater (Cork) as worthy of immediate investigation.

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THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

BY SIR WILLIAM NOBLE, M.I.E.E.

(*Continued from page* 302.)

HIGH-FREQUENCY TELEGRAPHY.

This paper would be incomplete without some reference to high-frequency or so-called "wired wireless" telephony. This system has received some attention in the technical Press of Europe and America during the past two or three years, and it is becoming evident that developments of the system are destined to play an important part in the future in long-distance communication.

The principle of the system has been known to scientists for a decade, but the solution of the practical problems involved in adapting it to commercial use was delayed in this country by the war. These problems are by no means inconsiderable or simple of solution. They involve researches into the behaviour of aerial wires and underground cables over a range of frequencies hitherto practically unexplored.

The characteristics of lines at the comparatively low frequencies of speech are well known, and apparatus has been designed which enables measurements to be made with precision. Such apparatus, however, is either entirely unsuitable, or suitable only with great modification for the purpose of making measurements at the comparatively high frequency of carrier-waves. The range of these waves lies roughly in the region between the highest note audible to the human ear and the frequencies used in wireless telephony. Over this range, factors which at audio frequency are so small as to be negligible become of first-rate importance.

It may be said that the most attractive, and at the same time the most valuable feature of the high-frequency carrier-wave system is its adaptability to multiplex telephony, that is to say, the simultaneous operation of several communication channels over one-wire circuit.

The system is already in commercial service in Germany and in the United States on long aerial telephone circuits, but the conditions under which those services are possible are practically non-existent in this country. Furthermore, it will be realised from what has been said previously in this paper that the economical value of the system for use in the United Kingdom lies in its application to underground cables. There are, however, a few cases where the system may be applied economically to aerial lines. Some of these are now being dealt with and will be brought into commercial service and linked up with the trunk system during the coming year.

DISCUSSION.

Dr. J. A. Fleming, F.R.S., in opening the discussion, mentioned that but for the effort to find sensitive detectors for wireless telegraphy and his own development and introduction of the two-electrode valve in 1904, it was highly probable that the thermionic valve would never have revealed itself as an ideal telephone repeater. The form in which it was now used in telephony was one of the standard form of valve evolved during the war as a wireless detector. No reference was made in the Paper to the work done in the U.S., in connection with the New York, San Francisco and Los Angeles telephone line, in which, with the thermionic valve, 140 miles of standard cable—about five times the possible distance for good speech—had been brought down to the equated length of 12 miles of standard cable, with 13 repeater stations; a wonderful performance. The author mentioned seven conditions which must be adhered to by the ideal thermionic valve for telephone repeater service, but he did not mention that the characteristic curve should be a straight line. No reference was made in the paper to an oxide-coated filament in the valves, but a great deal of work had been done in this direction in the U.S. during the war, and twice as many oxide-coated valves had been made there as plain tungsten valves. The life of the valve depended on the temperature of the heated cathode and it was claimed that the oxide-coated filament had advantages over pure tungsten. Had the Post Office investigated that point? Helium-filled valves had also been used largely during the war as repeaters, and they were an improvement on the hard tungsten valve. Finally Dr. Fleming mentioned a gigantic experiment last year in repeating from wireless circuits to wire circuits by means of the thermionic valve. A ship, the *Gloucester*, four hours out in the Atlantic, spoke by wireless to the mainland. This was relayed to the land line by thermionic valves to New York and from there on to the trans-continental line to San Francisco and Los Angeles, from whence it was again relayed on to the radio line and sent to the Pacific, and the operator on the Atlantic spoke to the operator in the Pacific without any human intervention. We were not, however, at the end of the possibilities of the thermionic valve yet. Submarine engineers would find it a powerful assistant in their work, but the history of its development had been one of the romances of electrical science.

Mr. A. J. Stubbs said that some engineers had thought we had reached the ultimate limit of efficiency in underground telephone work in this country in 1914, when we had thoroughly efficient underground circuits between London and Liverpool, but since then it had been shown that that was by no means the case. At that stage, 42 circuits represented the largest size cable that could be constructed between these two points, but four years later, by the introduction of the thermionic valve, the number of circuits was increased from 42 to 90, but by the simple process of subdividing that circuit into three instead of two, the number of circuits was increased from 42 to 240 equally efficient telephone circuits at about the same cost.

Mr. R. L. Jones (Chief Engineer, Western Electric Co., New York) said that in such a complicated system as that in the U.K. there were several hundred thousand circuit elements in which abnormal losses might occur, and a very high standard of transmission maintenance must be aimed at if the money value of these losses was to be kept from reaching a perfectly tremendous figure. In a repeater cable circuit, it might be possible for the repeater gains introduced to intensify about 95 per cent. of the total losses in the circuit. If the repeater gains should rise by 5 per cent. the circuit would become uncommercial and even inoperative due to speech distortion, whilst if the repeater gains should fall by 5 per cent., the circuit would again pass the commercial limit. In the plant of the American Bell system a large number of types of test equipment had been devised with the object of maintaining the circuits in a high degree of efficiency. Dealing with the trunk cables in America, Mr. Jones said there were now about 2,400 miles of trunk cable lines in use, and there would shortly be cable circuits in use for trunk working as long as 1,000 miles. Recently, there was put in service a 4-wire cable circuit about 1,000 miles long between New York and Reading. The circuit was of 20-lb. conductor, loaded in phantom. There were 22 repeaters, the gross equivalent was 550 standard miles and the net equivalent 10 standard miles.

Mr. J. H. Kingsbury quoted from a memorandum issued to those who were present at the inauguration of the telephone trunk lines in June, 1905. In this memorandum it stated that for the backbone line from London through Leeds, Edinburgh, Glasgow and Dublin, the heaviest copper wire ever used had been utilised. It weighed 800 lb. per mile, and it went on to say that efforts had been made to reduce the underground portion as much as possible, as underground wires seriously impaired the efficiency and clearness of telephone speech. That memorandum had attached to it a map of the backbone system in which there was not a particle of underground cable. There were 2,719 miles of 800-lb. copper, 4,914 miles of 600-lb., and

* Paper read recently before the Inst.E.E.

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3,025 miles of 400-lb. copper. Comparison of that map with the position to-day made it possible to realise the improvement that had taken place. There was no doubt as to the wisdom of the policy of laying underground cables, for it enabled them to keep the conductors in the best possible condition for transmission without risk of interference from the effect of storms. The developments since 1891 were such that the size cable then capable of giving speech only between London and Croydon could now be used, with the attachments mentioned in the paper, between London and Rome for diplomatic talk, or on a commercial basis from Glasgow to Milan. The relay had always been the aim of the telephone man, and the fact that the mechanical relay did not succeed did not surprise anybody, because obviously it could not be operated as a machine by a very attenuated current. The inertia of the working mechanism necessarily produced distortion. There was an uncanny operation about the thermionic valve, to his mind, because he could not measure it with a foot rule. He would like to ask Sir William Noble whether the development study which he had referred to was on a no-delay basis. That was very important, because with cables and repeaters it was possible to have alternative routes, and development on a no-delay basis was the thing to be looked forward to. Everybody wanted to be able to use a telephone at the moment of convenience, whilst half an hour later would be no good.

Mr. P. E. Erikson said that the importance of uniform line characteristics were recognised early in the developments of repeaters, and the accuracy of transmission depended very largely on the precision with which it was possible to make the artificial balancing line resemble the actual line. It was always possible to design a network to simulate the constants on almost any line, but obviously that was a cumbersome and rather expensive way of doing it, and an effort should be made to standardise and have as few networks as possible for commercial operation. He thought Fig. 8 in the paper, giving impedance/frequency curves for a 70-lb. loaded cable circuit, was a little misleading, because the conditions under which tests were made caused the curve to indicate that the impedance rises with the frequency, whereas, as a matter of fact, the normal slope of an impedance curve on a long loaded cable showed an actual decrease with increasing frequency.

Mr. F. Tremain said that in 1901 he had the good fortune to initiate the first loading experiment undertaken by the Post Office. The loading coils were imposed and super-imposed to produce various kinds of circuits. Experiments were carried out between London and Birmingham, and the result was the 4-pair cable, which was the origin of the quad-pair type, which he patented about that time, and which he still thought was the best type for super-imposing. This consisted of four pairs of wires round a centre of yarn, which had the effect of preventing cross-talk, whereas with air-space cables there was cross-talk. Further, if air space in cables led to a spongy condition, it necessitated vary careful balancing, and he would be glad if the author could say what the percentage addition to the cost of the cable would be as a result of having to balance it in this careful manner, and what the additional cost was of loading the cable. If it were possible to do away with balancing something would be saved, and a more suitable article produced. When these original cables were laid it was found that they were very susceptible to external interference, and telephone men called them neurotic. Modern medicine proceeded on the lines of prevention rather than cure, and it might be worth while to go back to something approximating to the solid conductor, so as to get greater radial stability. He had an idea that good results might be obtained with two wires combined together with enamel between them as the only insulation. A number of them could be made up into a wire rope by symmetrical winding of the wires. It might be that they would have a low capacity, but low capacity was not now such a vital factor as it used to be.

(To be continued.)

ELECTRICAL AND ENGINEERING TRAINING.

The Handbook and Syllabus of the Cambrian Correspondence Electrical Engineering School (Cemetery Road, Porth, Glam.), for 1921, deals fully with the necessity of study and preparation for the attainment of higher positions, and should be in the hands of the thousands of men engaged on practical electrical work who realise that the obtaining of a little more *technical* knowledge than they possess would enable them to improve their position and at the same time make their work more interesting. That the Cambrian Correspondence method proves satisfactory is indicated by the fact that in 1920, 207 sat and 189 passed the C. and G. Engineering Exams., i.e., the percentage of successes was 91¼, in fact for several years it has been round about this figure. Tuition is given on any engineering subject for any standard, and we find that the school, at first local, then national, is now world-wide—lessons by post being given in all parts of the world. The Handbook referred to runs to over 100 pp., and we commend it for careful perusal.

BELGIAN CONTRACTS AND FOREIGN COMPETITION.

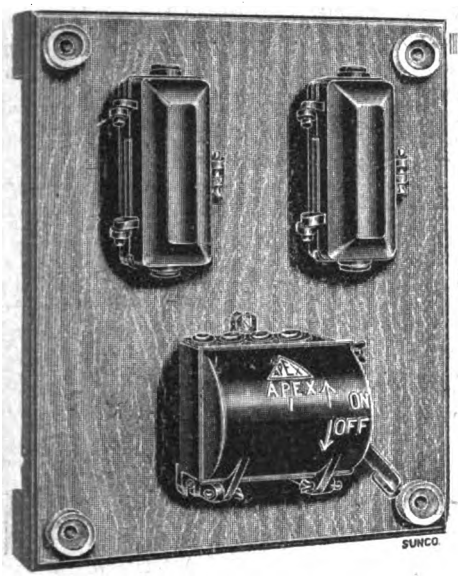
The principal reasons for the lack of success of U.K. firms in obtaining recent important Belgian contracts are, states Mr. R. F. H. Duke, M.B.E., Commercial Sec. to the British Embassy at Brussels, the present adverse rate of exchange and the activity of Belgian firms to supply the materials required. The majority of contracts which have come to Mr. Duke's notice have been obtained by Belgian firms simply because British contractors have had to quote prices in a currency which has depreciated by 100 per cent. It must be remembered that *industry in Belgium has, with few exceptions, almost completely recovered since the Armistice*, and also that the present trade depression makes firms willing to quote their lowest rates in the hope of obtaining an order and employment for their operatives.

According to an article in the *Chronique des Travaux Publics* the Belgian Railway Dept. has examined the question of the participation of German firms in public adjudication, and considers that no general rule can be laid down on the principle of permitting foreign competition, but that certain restrictions should be imposed favouring Belgian industry. Where Belgium is not necessarily dependent on foreign supplies it is proposed to give preference to tenders quoting unconditional prices in Belgian francs. It is also proposed to exclude foreign firms from contracting for public works of national importance from the point of view of defence. It is further stated that the Dept. considered that, in present circumstances, German and other foreign firms shall not be excluded in general from Belgian adjudications, but that a considerable right of preference ought to be accorded to Belgian firms in view of the difficult trade situation in that country.

Wireless Messages to Ships.—Owing to the creation of a special department for the routing of wireless messages, post offices in London and the Provinces will now accept such messages addressed to persons on ships at sea (which are within range of the coastal wireless stations of the United Kingdom) without requiring the sender to specify the station through which the message should be transmitted.

The E.T.B.I.—The number of members and subscribers is now 306, and, although during 1920 assistance was given to every qualified person who applied, the total amount of the invested funds (£14,355) is far from adequate to meet the demands for pensions which are certain to be made in the near future. The newly formed local advisory committees are at work in Cardiff, Glasgow, Manchester and Newcastle-on-Tyne, and it is hoped during the present year to get going on similar lines in Birmingham, Leeds and Liverpool. The report lists of governors, members, etc., and rules for 1921 are now available. Any additions to the ranks will be much appreciated by the Sec., Mr. F. B. O. Hawes, 18 and 21, Park Mansions, Vauxhall, Park South Lambeth Road, S.W. 8.

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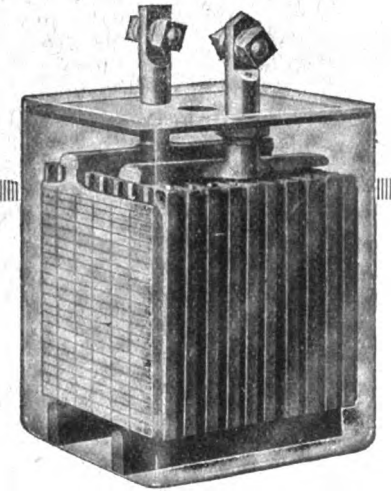
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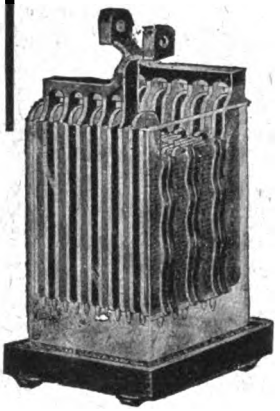
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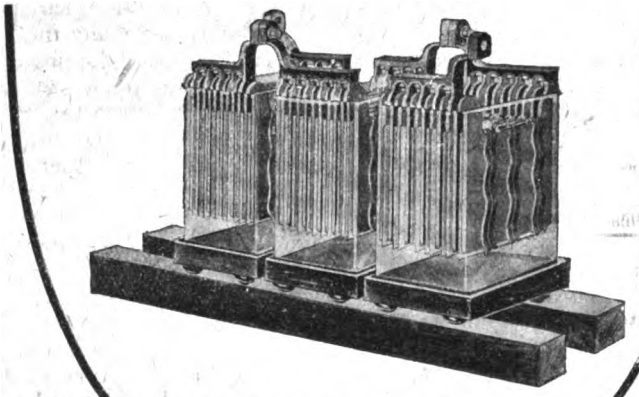
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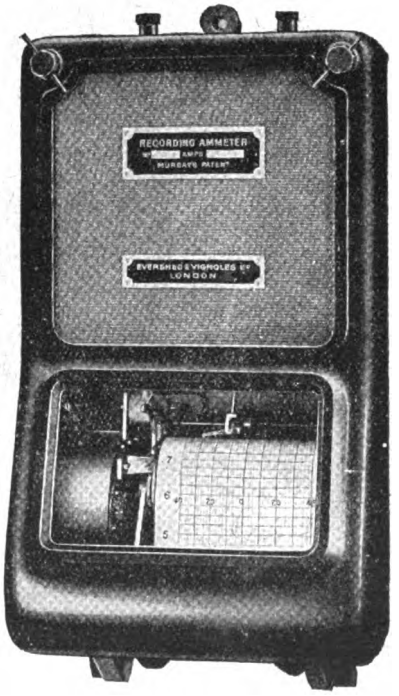


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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

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Current Topics.

Telephone Economy.

With increased telephone rates operating in every direction, it behoves the executive heads of big business establishments and institutions to survey their existing telephone installations with a view to drastic cuts and remodelling wherever possible on more modern and economical grounds. It is really extraordinary the amount of money which is spent by some establishments in the course of a year on telephoning, and quite unnecessarily in the majority of cases. I could enumerate several instances where, commencing with one or two public exchange connections in early days, the system has grown with a constantly expanding establishment until there are anything from a dozen to fifty separate exchange connections, radiating from different points, and mainly used for inter-departmental traffic.

The first step in reorganising a business telephone system is to plot out the existing connections with the Post Office system and prepare a careful analysis showing the extent to which they are severally essential to the daily conduct of business. In most cases it will probably be found that by a little ingenuity and concentration of important telephones at a few centres throughout the establishment, the number of Post Office connections can be reduced from fifty to seventy-five per cent. In all establishments, inter-departmental traffic, or telephone connections between two offices inside the establishment, constitute the principal load on the telephone installation, and it is simply throwing money away to pass these calls through a public exchange.

I would go so far as to say that there is not a business telephone installation in existence which could not economically be divided into two portions, one entirely private, for internal communication only, supplemented by a smaller system only connecting to essential points, for inward and outward calls to subscribers on the Post Office system. From the standpoint of convenience, the universal system is, of course, the best, but, in the light of modern charges and the discouraging policy of the State, many thousands of pounds can be saved annually by adopting the course above suggested. I would go a step further and recommend the automatic system for the internal installation, thereby speeding up the service and cutting out the wages of an operator or operators. Already many progressive firms, who are large telephone users, have adopted this policy of sub-division and effected considerable reductions in their annual payments for telephone service.

Railway Electrification.

The ever-increasing growth of road transport and the waning popularity of the railway should prompt sponsors of the latter form of passenger and goods transport to make some drastic change before the railways of this country become altogether derelict. Already America is alive to the danger, and in some quarters the electrification of steam railways is regarded as an economic necessity. One of the principal advantages attendant upon such a change is that the electric motor drive removes the restrictions imposed by the limitations of steam locomotive characteristics; whilst there is also a saving in fuel and labour, and an increase in track capacity following the adoption of electric traction.

How serious the road transport competition really is may be gauged from the fact that whereas it takes a pull of approximately 50 lb. to move a ton over the varying grades and surfaces of ordinary roads, the same 50 lb. pull will move ten tons over a railroad. Yet in spite of this disproportion, it evidently still pays to transport goods of a certain kind by road in preference to rail, a deciding factor being very often the door to door facilities afforded by the road transport system as compared with the frequent and expensive transhipment and consequent delays incidental to railway transport. The fact remains that the existing steam railways are rapidly losing ground and, unless they very soon introduce reforms of the character indicated, they look like following in the wake of the stage-coach of pre-railway days.

According to a leading American critic of the steam railway, such minor improvements in steam locomotive design as are already available, or in view, do not hold promise of any real relief from present operating conditions. The steam locomotive seems destined to spend the greater part of the year tied to the coal bunker, water tank, round house, ashpit, and repair shop, with too little time left for the actual haulage of trains. It is wasteful in man power, especially on heavy grade divisions, and in these days of high wages and short working hours, with severe penalties for delays leading to overtime, this low efficiency in utilising engine and train crews is fatal to economic success.

The steam locomotive is a notorious waster of fuel, burning a quarter of all the coal mined, and, finally,

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its cost of upkeep and depreciation are so high as to constitute a most serious percentage of the total operating expense. Perhaps this may seem a rather sweeping criticism of the steam locomotive. On the contrary, the facts are well known, although perhaps not fully appreciated unless compared with the operating records of other types of motive power. The steam locomotive has reigned supreme in the railway field for so many generations that to some it seems heresy to question its exclusive right to dominate it for all time. We have already had ample proof in this country of the possibilities of electric traction on short passenger routes where frequent stops are involved, and it cannot be said that our railway magnates have, in the main, neglected this branch of railway development.

It is to the main line routes that we must look for the next sweeping changes, and as an instance of the possibilities which lie ahead, it has been esimated from the performances of 60 huge electric locomotives operating over nearly 700 miles of route on the Chicago, Milwaukee and St. Paul Railway, that the passenger and revenue freight tonnage of the United States could be hauled by electric locomotives for one-third the coal now consumed under locomotive boilers. The most ardent electrical enthusiast does not advocate the immediate wholesale electrification of railways, but the above comparison affords a measure of the wastefulness of the present steam railway system, and the ultimate goal towards which electrification is directed.

In this connection there is a further important advantage accruing from electrification, viz., the elimination of the tender with its accompanying load of fuel and water which has to be carried as an adjunct to every steam locomotive. On the American railways the locomotive fuel carried in cars and steam engine tenders equals approximately 20 per cent. of the total revenue freight tonnage carried over U.S. railways, and practically the whole of this non-productive freight could be saved by electrification. The adoption of electricity, therefore, would immediately increase the carrying capacity of those railways one-fifth, simply by the elimination of the railway coal-carrying business. In face of these facts is the Transport Ministry alive to the potentialities of railway electrification in this country?

ELEKTRON.

Australia.—A copy of the Wiring Rules of the Fire Underwriters' Assocn. of Victoria, revised to Jan., 1921, may be consulted in the Inquiry Room of the Dept. of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1. These rules are the I.E.E. Wiring Rules adapted to meet Australian conditions. They have been adopted by the fire underwriters of all the States of the Commonwealth.

New Zealand.—Tenders will be received up to July 31 at the office of Messrs. Hay & Vickerman, Wellington, on behalf of the Wairoa Electric Power Board for the supply and delivery of material for a 11,000/3,300 volt 600 kw. outdoor substation. Material required includes: (a) Four 200 kw. 11,000/1,900 volt single ph. transformers, (b) Insulators, (c) Air-break switches, (d) Fuses, (e) Lightning Arresters and Choke Coils (all for 11,000 V. and 3,000 V.), and (f) Various accessories. Copy of the specifications, conditions of tender and plan may be inspected by U.K. firms on application to Room 49, Dept. of Overseas Trade, 35, Old Queen Street, S.W.1.

ELECTRIC ARC WELDING.

The subject of welding by means of the electric arc is rather fully treated in special publication 7783/2, issued by the Metropolitan-Vickers Electrical Co., Ltd. (Trafford Park, Manchester). The publication, which is amply illustrated, runs to 28 pp. and opens with a brief reference to the various systems of welding. Arc welding is next treated from the point of view of its many applications, and then the welding of different materials and the effects of impurities considered. The carbon electrode and metallic electrode processes are both dealt with and some practical suggestions given. It is of the greatest importance that the electrical equipment be such that the operator can maintain a stable arc in spite of (*a*) unsteadiness of the operator's hand, (*b*) variation in the length of the arc caused by molten metal travelling from the electrode to the weld, (*c*) foreign matter such as scale, rust, etc., in the path of the arc, (*d*) unevenness of the surface over which the welding is directed.

In order to obtain stability a variable voltage is required, which will automatically prevent interruptions due to these causes, and at the same time give approximately constant watts at the arc so as to have constant heating effect. The most common way of obtaining this variable voltage is by using a constant voltage supply, and connecting a suitable resistance in series with the arc. Successful welding has been accomplished for years with such equipments, and this establishes the fact that the voltage characteristic of such a combination fulfils the special requirements of arc welding.

The relation between the voltage drop across the arc and the current of the arc is given graphically by the straight line sloping from the open-circuit voltage value on the voltage axis to the short-circuit current value on the current axis, the latter being determined by the ohmic value of the series resistance. The limiting feature in maintaining a stable arc is that this line must not be too nearly horizontal, and on the other hand, it must not be too steep. In the latter case, there would be a tendency for a careless operator to work with a long arc. In practice the best conditions for carbon arc welding are realised when the voltage drop across the resistance is half that across the arc, and for metallic arc welding when the voltage drop across the resistance is twice that across the arc. A voltage at the carbon arc of 30 to 50 volts and at the metallic arc of 18 to 25 volts calls for a constant voltage supply of about 70 volts.

Although this system of supply is satisfactory, it is inefficient on account of the losses in the series resistance. When a metallic electrode is used the losses in the series resistance amount to more than twice the total energy used in the operation. The remarkable manufacturing economies which have accrued from the adoption of arc welding have served to obscure this fact, but if arc welding is to attain the measure of utility it deserves, more efficient methods of supplying the electrical energy must be used.

In order to obtain a better efficiency a generator has been developed by the Metropolitan-Vickers Electrical Coy. with a variable voltage characteristic closely following that described above, and arranged so that the arc may be connected directly to the terminals of the generator without any series resistance or current

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limiting device of any description. As a result it is possible also to use a smaller prime mover, especially for plants designed for the metallic electrode process than is usually the case. It should be noted, however, that only one operator can work at a time with such a generator, and it has thus been designated the "Single Operator" type generator. It has been carefully tested at the Manchester works of the company and, we are informed, is giving satisfactory results in daily operation in the shops there on constructional and repair work. Although attention is specially drawn to this development, standardised sets are available, comprising level compound wound generators with stabilising resistances suitable for multiple arc operation.

The "Single Operator" generator is adjusted for different welding currents by means of a shunt field regulator, which changes the open-circuit voltage, each change producing a parallel characteristic. A further adjustment is provided on the series field winding, whereby the slope of the characteristic may be changed. These adjustments make the generator effective over a very wide welding current range.

Correspondence.

COST OF INSTALLATION.

To the Editor of ELECTRICITY.

SIR,—In an interesting and practical paper read by Mr. F. D. Alldread before the National Association of Supervising Electricians, he stated that there is very little difference between the cost of an installation carried out on the screwed system as compared with one carried out on the grip system.

A case that occurred the other day in a factory not a hundred miles from Birmingham furnishes a good illustration to the contrary.

Some motors had to be installed to run on the 440-volt supply, and several motors had to be installed on the 220-volt supply. It was arranged that the 440-volt circuits should be run on screwed tubing, and the 220-volt should be wired on the Walsall Grip System. The most experienced man of the two men employed was given the job of carrying out the screwed work and a man of less experience carried out the work of the grip system. The runs in both cases were almost identical, but it was found that it was possible for the less experienced man to wire up three motors in the time that it took to wire up one motor on the screwed system. The man doing the screwed work was taxed with being somewhat slow, and retorted that he would guarantee to wire up at least four motors on the grip system while one was being wired up on the screwed system.

Mr. Alldread in his paper did not sufficiently emphasise that although the Grip fittings are practically equivalent in cost to screwed fittings, the tubing necessary is very much cheaper, and the saving in labour on most installations is very considerable indeed.

We all agree that in some circumstances a screwed installation is absolutely the best, but I contend that a great deal of money is often wasted in installing screwed work where an installation with the Walsall Grip System would give equally good results.

With regard to the electrical continuity of the sheathing, Mr. Alldread emphasises the necessity of seeing that the enamel is always removed from the tubing before insertion into the fittings, but I should like to know if he has ever taken out any tests for continuity even if this removal of the enamel is omitted. While I agree that it is advisable to insist upon the removal of enamel being carried out, it is certainly surprising what heavy currents can be carried without any overheating of the joints by a run of tubing and fittings, even if the removal of the enamel is omitted.

174, Corporation Street, Birmingham. May 25, 1921.

Yours faithfully,
D. G. BROOKS, A.I.E.E.

ELECTRICAL INSTALLATION WORK.

Solutions to Questions set in the 1920 *Final Examination of the City and Guilds Institute.*

BY W. H. BRAY, A.M.I.E.E.

(*Continued from page* 813, *vol.* xxxiv.)

Q. 8.—Give your reasons why alternating current is sometimes used in preference to direct current, and state the relative advantage and disadvantage of each system.

A. 8.—This question opens up many points for discussion, but it can be safely said that the one outstanding factor in favour of the use of alternating current is that the secret of success in the transmission of electrical energy lay in the use of high voltages, as this permits of the use of comparatively small currents with corresponding small conductors and electrical losses.

For these high voltages alternating currents are much more suitable than direct current, for the following main reasons:—

1. Alternating current generators require no commutators and, therefore, the difficulties of high voltage commutation, and the necessary high insulation required for the commutator are eliminated. For the same reason (no commutator) alternators can be run at higher speeds and, if necessary, the current can be generated at the full voltage required.
2. Alternating currents can be transformed from one pressure to another, either up or down, by means of a simple statical transformer which involves no moving parts.

It is for these two reasons that alternating currents are being adopted in all modern schemes of electrical supply and transmission of power.

Direct current high voltage systems of power transmission have, and are, being used, notably those designed by M. Thury; but it must be remembered that direct current generators working at pressures over 1,000 volts require more care in the due insulation of every part, and special attention has to be given to the design of the commutator, especially when the machines are to be run at a fairly high speed, in which case, owing to the high peripheral speed of the commutator, carbon brushes cannot be used.

The disadvantages of an alternating current supply are:—The high maximum voltages attained, and therefore the need of corresponding high insulation.

The loss of power due to wattless current.

Loss of pressure due to induction.

And, where the periodicity is high, or the current large, the increased I^2R losses in the mains due to the so-called "skin effect."

The advantages given, however, far outweigh the disadvantages.

The reasons for, and the advantages gained by, the use of an alternating current supply apply more particularly to the Supplier. When it comes to the question of the User, the balance is more in favour of a direct current supply.

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From a purely lighting point of view, with incandescent electric lamps, there is little to choose between the two systems, but for arc lamps the direct current is much to be preferred, and in the case of arc lamps for cinematograph work, which are used so extensively all over the world, if the supply be alternating current it is, in practically every case, converted to a direct current supply, because of the latter's much greater lighting efficiency.

In the case of power the direct current motor has many advantages, with its fine starting torque and easy speed variation. This is very apparent when you compare it with a single-phase induction motor with its expensive starting gear and poor starting torque. This latter case does not, of course, apply so much to a three-phase motor.

When it comes to the case of the use of accumulators and electrolytic work, we find that direct current only can be used, and if the supply happens to be alternating current then, for these purposes, the alternating current must be converted into direct current by means of motor generators, rotary converters or some kind of rectifier.

Q. 9.—It is required to raise 1,000 gallons of water per hour over a total head of 20 feet, including friction of pipe. What must be the horse-power of the motor?

The efficiency of the motor is 78 per cent. and of the pump 30 per cent. One gallon of water weighs 10 lb.

A. 9.—In this question we have to find the necessary horse-power of a motor to do a certain amount of work in a given time.

If we remember that *Power* may be defined as "the rate of working," and that one H.P. is equal to the work done in raising 550 lb. through a distance of one foot in one second, or in raising 33,000 lb. through a distance of one foot in one minute, the solution to the above problem will become quite simple, for:—

$$\text{H.P.} = \frac{\text{weight in lb.} \times \text{height in feet}}{33{,}000 \times \text{time in minutes.}}$$

It must be noted, however, that in the question set, in addition to the work of actually lifting the water to a height of 50 feet, we have to provide a motor of sufficient power to overcome the frictional resistance of the pump as well, the efficiency of which is given as 30 per cent.; our equation therefore becomes:—

$$\text{H.P.} = \frac{\text{W. in lb.} \times \text{H. in ft.}}{33{,}000 \times \text{T. in min.}} \times \text{efficiency of pump}$$

$$\therefore \text{H.P.} = \frac{1{,}000 \times 10 \times 50}{33{,}000 \times 60} \times \frac{100}{30}$$

$$\text{H.P.} = \frac{500}{594} = 0.84, \text{ say } 1 \text{ h.p.}$$

In the question, the efficiency of the motor is given as 78 per cent., but to arrive at the horse-power of the motor required for this particular case no notice is taken of this information, as it has no bearing on the question set.

(To be continued.)

Another Ideal Home Exhibition.—Sometime in November an Ideal Home Exhibition is to be held in Newcastle.

HINTS ON LOCALISING AND EXPEDITIOUS METHODS OF REPAIRING FAULTS IN COLLIERY A.C. PLANT.*

By E. CUNNINGHAM.

(Continued from page 287.)

A Member.—When Mr. Cunningham spoke about closing the circuit breaker and utilising same to find out where the fault existed, he said he had found it was often the case that the closing of the circuit breaker made the fault re-act and caused further trouble elsewhere; by that he meant to say if a short circuit really took place and the breaker was put in against it, it very often re-acted on the breaker itself.

Mr. Walker said he was very interested in Mr. Cunningham's paper and had just one or two points to mention. For instance, regarding the locating of the fault in cable. As Mr. Munro said, the case that Mr. Cunningham did take was very favourable indeed, but he, the speaker, was not so sure that it would hold good inbye where there was so much iron work in the earth; he took it that the compass would be very much affected. He had seen cables tested on surface with the compass and at one place when they thought they were coming near to the fault, and tested a little further on, they got another reading, and so on until they could put no faith in the compass at all. Personally he had never found the compass of much use. Very often cable fault finding usually ended in the pick and shovel and cut and test each way. By cutting, of course, it is meant that in the first place the disconnecting boxes be opened up.

He admitted, of course, that in the instance given by Mr. Cunningham the conditions were quite favourable. He would like to have heard, however, if he had tried it in any other place about the pit. Another point was that a lot depends on the nature of the fault. Supposing, for instance, that it was a short between cores and an earth on as well, he wondered how that would affect it?

Mr. F. Sims.—With regard to the cutting out of windings he supposed it was a very common thing with D.C. plants. He had had occasion to cut out two or three coils with quite good results. He thought that machines where part of the damaged windings had been cut out would run quite safely provided they were not overloaded.

Mr. Greenwood said he agreed with Mr. Cunningham in the case he had mentioned that it was a suitable one to cut out a winding. One could not, however, use the method indiscriminately. Supposing the machine was a two-pole stator, a small machine which might have six slots in the hole per phase. To cut out two or three coils of this machine was considerable, and if the method of cutting out was carried too far it was bound to meet with trouble. It could not be regarded as a standard method of repairing, and if people got that impression they were liable to have a troublesome time. He agreed, however, that in the present instance no harm would be done.

Mr. Walker.—As regards the cutting out of windings, he was in agreement with the last speaker that the cutting out could be carried a little too far. When a machine was interfered with and a few turns cut out, a proper official

* Paper read at a meeting of the Lothians Branch of the Association of Mining Electrical Engineers, Edinburgh, on November 27 With acknowledgments to *The Mining Electrical Engineer*.



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record of what had been done ought to be kept, because, for instance, a man who was responsible for cutting out may be there all this year but perhaps away next. If no record was kept the new man came along and did not know about the previous fault. If the machine again gave out and he thought it advisable, to keep things going, to cut out a turn or two, were an official record kept he could look this up and would observe that someone before him carried out an operation and that he would have to be very careful and use his own discretion as to how far he could then go.

Mr. McGhee.—Regarding the cutting of the cable. In these days when such expensive cables are being used, to start and cut the cable half way to locate certain faults seemed to be a bit out of place. Why not have disconnecting links put in the same way as with the distribution system, such as are used for towns' supply? It would then be quite a simple matter to break up these points and test either way. Mr. Cunningham's compass method of testing was a very good one. The telephone method was mentioned and he remembered once having a little experience with this instrument. A D.C. armature gave out, and there being no instrument at hand such as a milli-voltmeter or megger, a set of telephone head gear used for exchange purposes was picked up with the result that the fault was located straight away.

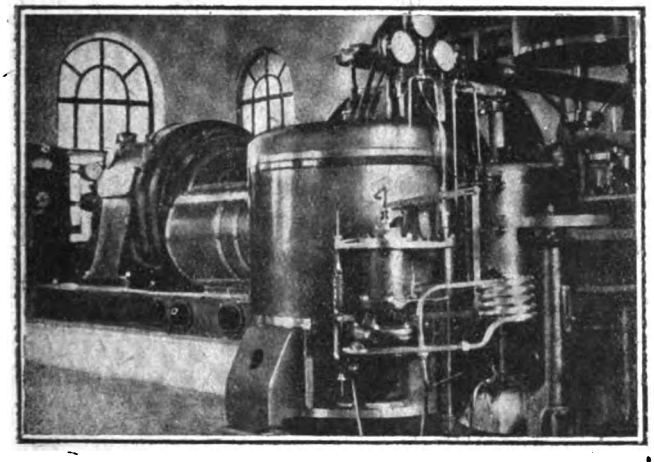


FIG. 7.

Mr. Cunningham, in his reply, said that most of them were agreed that one could overdo the cutting-out business. It was quite true, if it were carried out indiscriminately. That was not the point, however. One would not cut out half a winding. The usual rule in A.C. work was that it was quite safe to cut out up to one-fifth of the winding on the stator and the rotor. Of course, it was not a standard method of carrying out repairs and only done until such times as replacements came along. It was to save time that cutting out was done, and after all, time was a very important thing in a colliery. One might lose 200 tons of coal due to an hour or two's stoppage in the forenoon. If the fault was cut out and the machine made to run to ten o'clock at night, it might be replaced during the night shift. A member had taken up the circuit-breaking method. Sometimes it did rebound. Before he, Mr. Cunningham, would test with the circuit breaker he would alter the setting to the smallest possible. These breakers were very sensitive and no sooner were they pushed in than they flew out again. It was a very convincing method, however. With a megger one might have a lot of work and trouble disconnecting before proceeding to test, and then again with the circuit breaker there was no chance of burning it out. With the latest type of circuit breakers it is not possible to hold on against the fault. In testing with the breaker the idea was the saving of time, and with a megger one could get badly misled with a circuit. Mr. Walker had spoken about the compass method. He (the speaker) had tried it with success on a cable running inbye. Regarding the compass being

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affected with the iron down below, he did not see how that could be. The surveyor's compass would not be reliable if affected in that manner. Magnetic influence of the iron due to the circuit was sufficient to influence the needle if it be held close enough to the cable.

Then again, it was mentioned about a short between cores and an earth also. If the circuit was made he did not see that it made any difference to the magnetic field in the iron, or that there would be a complete circuit through the armouring. The circuit would be merely through cores and it would not make any difference.

He quite agreed with the method of keeping a record of cutting out coils if the machine had to be there for any length of time. It was necessary, however, to get the repair properly done at the first convenient opportunity; still, sometimes in the case of a big motor it may be left long enough. Personally he had a record of these and also the photographs, so that anyone coming after could see that the coils had been cut.

Mr. McGhee had taken up the point about testing with a bridge. Mr. Cunningham did not know whether he had had much experience in colliery work, but he would say that if the short was a high resistance one he would have a very bad error. If it was an arcing short, it was a question if one could not be a good few yards out in a big cable and he would need to go on cutting here and there. Cables were too valuable to be cut up at random: a fault in the colliery cable had to be located to the nearest foot. With the compass method one can come within three or four inches of the fault, and he had never yet seen it fail.

As regards the breaking up of the cable, the points were really disconnected at what would be called a one-way distribution box. It was connected at the busbar. Do not cut the cable, but take the nearest part where it could be disconnected. The disconnections would be made at the busbar chamber.

THE "REFLEX" PENDULUM CONTROL.

A TIME-DISCIPLINE APPPARATUS.

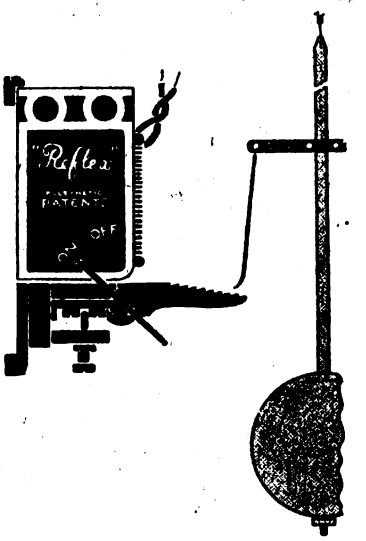
The introduction of a mechanism for controlling the pendulums of workmen's registers should have far-reaching effects, as, although many modern firms have adopted an impulse or time circuit in their factories, some have withheld from fitting their workmen's registers with electric control, owing to the fact that an interruption of the time circuit disturbed the workmen's registers as well as the clocks.

When unification of workmen's registers was first attempted, the electric clock-maker proceeded to do so by substituting for the spring-driven clockwork an electrical step by step or impulse movement. This avoids the necessity of winding, but introduces other troubles, because the comparatively low power of the impulse movement leaves little margin for stiff places in the clock mechanism, which stiff places occur from time to time as the register is used, and the gears of the mechanism become clogged with dust, etc. Then again, during any structural alterations to the premises, the time circuit is liable to disturbance and even stoppage unless great care is used, and consequently the checking and costing system is disorganised.

The next step to overcome some of these possibilities was to "scape" the existing mechanism electrically. By this method the pendulum was removed, and an electrical scaping mechanism substituted, which, operating every half-minute by means of the time circuit, allows the clock train to run on in half-minute intervals. This principle is sound and practical, but still it does not remove the possibility of a stoppage if the time circuit is interrupted for the reason just mentioned, and, moreover, the removal of the pendulum permits the maker to plead interference it the type mechanism needs attention.

The latest development is seen in the "Reflex" Pendulum Control made by Messrs. Gent and Co., Ltd., Faraday Works, Leicester. The device is, we understand, already in use by a number of firms. By the arrangement nothing is removed from the register, but the "Reflex" control mechanism is added. This consists of two main parts, one the "Vibrator," which is clipped to the pendulum rod, no drilling or tooling being necessary. The other part, or "Stator," is screwed to the woodwork of the register by wood screws or by nuts and bolts, as may be desirable.

The register is "wound up" in the usual way. It operates by the clockwork exactly as supplied by the



maker, but by the "Reflex" movement the pendulum is compelled to keep time with the transmitter controlling the time circuit of the factory and the other clocks in the circuit. The pendulum should be so rated that the clock does not "gain," i.e., it must be given a slightly losing rate, but need not be set to lose more than two minutes per day of twenty-four hours. So effective is the control that in a pendulum beating 88 per min., as is the case with some of the best known makes of recorders, it will effectively deal with a loss as much as ten minutes per day.

The points of criticism detailed in the first two devices are, therefore, removed, in that:—

(1) The addition of the "Reflex" control does not free the maker of the register from his responsibility, and the mechanism can be removed entirely in five minutes.

(2) The type wheel, mechanism and dial of the register are all operated by the powerful clockwork provided by the maker.

(3) If the electrical time circuit is thrown out of commission the register does not stop, but carries on as a separate mechanical unit, and it is not affected in any way except that it is no longer under electrical control, so that if the electrical circuit is temporarily out of commission this does not materially interfere with the costing and checking system.

(4) The necessary losing rate is a distinct advantage inasmuch as the management know that, in the event of the time circuit being out of commission, they have the assurance that the employees will not be unjustly "clocked" out at the time of registering, as would be the case if the clocks were liable to gain.

The value of this feature cannot be over-estimated, because of the lessening of the possibility of friction with the workpeople.

Inst. of Municipal and County Engineers.—The Gen. Meeting and Conference will be held in London from June 15 to June 18. On the 16th there will be a demonstration of mechanically propelled, including electric, vehicles for municipal work in Lincoln's Inn Fields.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 119.

There were some fuse boards recently served into our works. The fuse clips are fixed to iron rods insulated with what appears to be mica or micanite. I would like to know how mica is placed round the iron rods in this manner, and what material I shall require to insulate the rods if a breakdown should occur.—"CLIP."

QUESTION NO. 120.

The distance between my house and a store is two miles. I wish to rig up a signalling apparatus between them so that I can be called up at the store if I am required at the house. I do not wish to go to the expense of fitting electric bells on account of the cost of wire and the inconvenience of running them. Can I use a system of wireless? If so, please can you give me some details that will assist me?—"COHERER."

(Replies to Questions Nos. 119 and 120 must be received not later than June 25, 1921.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.

THE ELECTRO-DEPOSITION OF COPPER. By C. W. Denny, A.M.I.E.E. (Pitman, 2s. 6d. net).—This is another of Pitman's technical primer series, and its appearance will be very welcome. Mr. Denny deals with the subject in a masterly manner from the principles of electro-deposition and the testing of solutions to electrolytic refining and electro-deposited radiators. There appears to the reviewer to be only one fault with the book. It does not deal with a sufficiently long range of subjects. This, however, is probably due to the fact that as a *primer* it must not be considered in the same light as a text-book. This is to be regretted because there is ample scope for a book dealing with the electro-deposition of copper in the motor-car industry alone. Recently, copper plating has been greatly resorted to where a part of an article is to be hardened. In a cam shaft, for instance, it is only necessary to harden the cam profile. Here, if the remainder of the shaft is copper plated the absorbtion of carbon is prevented. This method enables the shaft to be made from one piece of material and so eliminates the necessity of making and fitting specially hardened steel cams. The book is to be recommended to students and electro-platers, and some designers will find information to interest them in its pages.

SENIOR PRACTICAL CHEMISTRY. By H. W. Bausor. 217 pp., 31 figs. (University Tutorial Press. 3s. 6d. net.).—This book is one of the comparatively few treatises written to serve a really definite purpose and, as is usually the case, that purpose being served most ably, the book will also prove valuable to a wider circle of students than those for whom it is ostensibly written. The definite aim which the author has in view is to meet the requirements of the Senior Cambridge Local Examination in Practical Chemistry. Part I. of the book deals with carefully selected preparations and experiments, full working details and diagrams (where necessary) being given. The action of heat on a number of substances is also considered carefully. Part II. is devoted to quantitative analysis, both gravimetric and volumetric methods being given. Part III. is concerned with the qualitative analysis of simple salts.

Throughout, the book is very clearly written and arranged, and its low price places it within the reach of all students. The selection of model analyses at the end of the book appeals to us as being particularly useful. Chemical education in this country has a great deal of leeway to make up, and this book should assist materially in the good work.

ELEMENTS OF ILLUMINATING ENGINEERING. By A. P. Trotter. 104 pp., 63 figs. (Pitman, 2s. 6d. net.).—"Students, junior engineers, architects and others," form the class for whom the author has written. And right well he has done it, as was only to be expected in view of the attention he has devoted to the subject in his official capacity. The treatment is concise throughout and, therefore, every section of the subject has been able to receive due recognition in proportion to its importance. The only criticism is that it is a pity that more space was not available so that a slighly fuller treatment might have been given. In line 11 it would be clearer if the word "hemispherical" were inserted before the word "flux." From these remarks it will be appreciated that there is no need to go into detailed criticism, but we might remark that the book is as up to date as is possible with such a rapidly progressive art.

A NEW CINEMATOGRAPH LAMP.

The ordinary cinematograph lamp for currents between 30 and 70 amps., or even up to 100 amps., has the carbons in line, and only slightly tilted from the vertical, so that the crater of the upper carbon shall burn away in front. From 5 to 7 hand-wheels are fitted to permit common and individual adjustment of the carbons, so that the crater may be kept in focus, from which it is continually tending to depart. Obviously the optical conditions can be much improved by making the upper (positive) carbon horizontal, but it has hitherto been found impossible to stabilise the arc in this type of lamp with a higher current than 30 amps.

In their new projector lamp, described in *Electrotechnik und Maschinenbau*, the Körting and Mathieson Co. claim to have solved the problem of satisfactory burning with horizontal positive carbon using currents as high as 80 amps. The crater being practically vertical, from 25 to 50 per cent. more light is said to be projected on to the screen for equal watt consumption, and the screen is, moreover, uniformly illuminated top and bottom. Only three hand-wheels are necessary, one for raising and lowering the lamp vertically, one for common movement together of both carbons, and one for advancing or withdrawing the top carbon. The arc is centred by a blow-magnet. Satisfactory operation is claimed on a.c. as well as d.c. Polar curves of the new and old types of lamp are reproduced.—(*Technical Review.*)

Electricians' Conference.—At the E.T.U. conference, Blackpool, a gold watch was presented to Mr. J. W. Ball, of Manchester, by Mr. Humphries, of London, in recognition of 20 years' service to the Union. The conference decided against affiliation with the Third International.

Meetings.— A Wireless Section Meeting of the Inst.E.E. will be held at the Inst. Building, Savoy Place, Victoria Embankment, W.C.2, on Wednesday, June 8, 1921, at 6 p.m., when the following paper will be read and discussed :—"Electric Oscillations along Straight Wires and Solenoids," by Professor J. S. Townsend, F.R.S.

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Trade Notes.

The London Shafting and Pulley Co. have moved to Northdown Works, Northdown St., King's Cross, N. 1 (next to King's Cross Metropolitan Rly. Stn.). The telephone No. is North 196.

Gent & Co., Ltd. (Faraday Works, Leicester), manufacturers of electric clocks and allied mechanism and devices, and of telephones, etc., illustrate in folder No. 54 their Regent C.B. Industrial Telephone. Contractors and prospective users who have not investigated the system should make a point of doing so. It is simple and reliable.

The thorough investigation by the **Metropolitan-Vickers Electrical Co., Ltd.** (Trafford Park, Manchester), of the individual drive of looms has enabled them to produce reliable and efficient electric motors for the purpose. These motors, together with specially designed loom control switches, have been installed in many weaving sheds, illustrations of some being reproduced in a booklet, 7875/2, which points out the disadvantages of shaft drive. Among these is that as the principal motions absorbing power in the working cycle of a loom are the picking, treading and beat-up operations, which constitute the loom itself an irregular-running machine, still worse conditions will be caused by the application of an irregular driving agent such as a long belt. With the individual drive greater flexibility, a lighter building, the possibility of sectional working, a smooth drive, improved lighting and cleanliness and increased freedom from shut-down are afforded.

Folder F 2451 issued by the **G.E.C.** is devoted to pendants for semi-indirect lighting with Osram gasfilled lamps, including the smaller sizes for domestic use. The pendants can have either opal or "Equiluxo" hemispheres.

Various Items.

Accrington.—The Electricity Works have sustained a loss on the year of £12,000.

Preston.—The American and Canadian Trade Delegation, at present touring this country, visited Preston on May 26, and inspected various large works, including those of English Electric Co. (Messrs. Dick, Kerr's) and the Leyland Motor Co.

Bryn.—The Margam D.C. have decided to light Bryn by electricity. The initial cost was estimated at £12,000 and Messrs. Baldwins, Ltd., have met the Council with regard to the use of their overhead cable, which runs throughout the area.

What the User of Electricity Ought to Know.—E.D.A. publication No. 162 is of value as a business-getter, as it is conceived in the spirit of stimulating a desire on the part of householders without an electric supply to obtain a supply. Contractors and Supply Undertakings should make full use of it. Another E.D.A. publication is "Electricity on the Farm," by R. Borlase Matthews.

A Substitute for Petrol.—Natalite Motor Spirit, a South African product, is said to be proving an efficient substitute for petrol. It is a mixture of alcohol, ether and ammonia. Most of the world's patents governing its manufacture and sale are controlled by the Alcohol Fuel Corpn., Ltd., 7, Princes St., Westminster, S.W. 1. The first consignment of Natalite has just reached the Port of London.

Inst. E. E. Council.—The President announced at the meeting on May 26 that the following had been elected to fill the various vacancies occurring in the Council on Sept. 30 next:—President, Mr. J. S. Highfield; Vice-presidents, Prof. E. W. Marchant and Mr. C. C. Paterson; Hon. Treas., Sir James Devonshire; Ord. Members of Council, Messrs. S. Evershed, A. Page, T. Roles and Lieut.-Col. F. A. Cortez Leigh, T.D.R.E. (members), Sir Andrew M. Ogilvie and Mr. A. W. Tait (associates). There was a very heavy poll.

An Ediswan Outing.—The ladies of the Ediswan Ponders End Staff organised and carried out an extremely successful picnic on Sat., May 21. A party of nearly a hundred left the works in three charabancs for Ruislip Common, where, in due time, tea was taken. The party then continued the journey to Uxbridge, where a dinner was held at the Chequers Hotel under the Chairmanship of Mr. J. W. Elliott. Afterwards a short concert, organised by Mr. A. P. Ambler, was given. The artistes were Miss Hutt (piano), Mr. S. Barker (baritone), Miss Outten and Mr. H. G. Holyday (duets), Mr. E. H. Miller (humorous) and Mr. and Mrs. A. P. Ambler (songs and chatter). The return journey was made through town, Ponders End being eventually reached about midnight.

Personal.—Mr. Harry Garstang, electrical engineer, who has served the Blackburn Rovers as a director for many years, is completing his term this year, but is eligible for re-election.

Whitleyism.—The elevation of the Rt. Hon. J. H. Whitley, M.P., to the Speakership of the House of Commons has impelled him to sever his co-partnership presidency of the Industrial League and Council, but Viscount Burnham, C.H., has accepted the position. He has long been an interested advocate of the principles which the league enunciates, and in conjunction with the Rt. Hon. G. H. Roberts, M.P. (Joint President), will, we are sure, steadily improve the relations between employer and employed on the approved "Whitley" principles, on which alone can harmony be restored in the industrial world. The May issue of the "Industrial League Journal," is of interest in that it contains interesting biographies and photographs of both the Rt. Hon. J. H. Whitley, M.P., and Viscount Burnham, C.H. Incidentally, the publication has a full report of the Annual Meeting and Dinner of the League, at which such pertinent remarks were made by both the Rt. Hon. G. H. Roberts and Mr. James O'Grady, M.P., relative to the present industrial trouble.

Service Notes.—In connection with the Defence Force the following temporary appointments have been made:—London Electrical Engineers—Lieutenant-Colonel A. E. Rossignal, C.B., T.D.; Captains H. K. B. Reed, T. W. G. Acland, I. S. Macadam, O.B.E.; T. C. Mann, M.B.E., and E. Matthews; Lieutenants G. St. J. Sugg, C. G. Huntley, H. F. Cousins, W. J. Rawlings, A. B. Penney, L. S. Foster, G. C. King, and A. W. King; Quartermaster and Captain S. W. P. Goodwin, all war veterans. Tyne Electrical Engineers—Lieutenant-Colonel E. Robinson, M.B.E., T.D., Major H. E. Burton, O.B.E., Captain C. M. Foster, Lieutenants C. B. Williamson, R. P. Winter, M.C., E. H. E. Woodward, M.C., R. Sharp, O.B.E., C. F. Fawcett; Captain and Quartermaster A. Reed. Lieutenant-Colonel Rossignal won the C.B. by his services in the late war and Lieutenant-Colonel Robinson received his decoration for valuable services rendered during the same period. Since being gazetted as above, Lieutenants R. Sharp and Woodward, Tyne Electrical Engineers, have been promoted captains. Captain W. H. Pay and Lieutenant W. B. Davies have been posted to the Electrical Companies of the Defence Force. Recruiting for the electrical branches of the navy and army is very good, the good pay and better service conditions attracting a good class of recruits. The larger type of cruiser which is being evolved, as a result of war experiences, will be more electrically fitted and controlled than any of the types presently in commission. There is a likelihood of the turret mechanism returning to current propulsion. It must be admitted that electrical propulsion of turrets was not altogether a success in the late war, but matters electrical have considerably advanced since then.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
JUNE 10, 1921.

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SOMETHING ABOUT WASHING MACHINES AND OTHER LABOUR-SAVING DEVICES.

The education of the public in the obvious advantages of the electrically equipped home has now been slowly but surely proceeding, and it is confidently anticipated by those in the best positions to judge that in the near future there will be a large demand for such labour-saving devices as electric washing machines, small motors adapted for driving various utensils, etc. Already there is a vast and growing demand for electric vacuum cleaners, irons, heaters and cooking devices.

We have passed through the experimental stage with regard to most of the above and thoroughly reliable and efficient vacuum cleaners, irons, heating devices and small utility cooking devices are manufactured by firms of the highest repute, so that there is no reason at all for the foisting of bad apparatus on the public. With regard to washing machines, however, which, like so many other labour-saving devices originated in the United States, it is only comparatively recently that they have become less than a novelty in this country. It is hardly surprising, therefore, that the state of the market does not yet warrant their manufacture over here, and the U.K. is the happy dumping ground of unsuccessful and obsolete patterns for which there is no market with the shrewd and wily American public. There are a few machines of proved value on sale, and in order to ensure that the present prospect of a large and flourishing trade be not prejudiced it behoves contractors and dealers to look to it that they only supply machines of absolute efficiency and reliability. It is our purpose here to refer to one such machine—a machine which we recently inspected in operation and one which is perhaps the best all-round washer that has ever been produced. It is known as the A.B.C. Super Electric Washing Machine, manufactured at Peoria, Illinois, by Altorfer Bros. Company, the largest exclusive washing machine makers in the world (200,000 have already been sold), and its sponsors in the U.K. are the Sun Electrical Co., Ltd., of 118 and 120, Charing Cross Road, W.C.2, who hold the sole wholesale selling agency. Some 18 months ago they started investigating the electric washing machine business and have spent considerable time and money in obtaining and testing practically all makes. Their experiences have led them to the conclusion that the A.B.C. Super Electric is the washing machine most perfect in every detail.

As may be seen by reference to the illustrations the mechanism is entirely enclosed and we are convinced is throughout substantial and on the most approved engineering principles. In operation about ⅛ h.p. is required, but a ¼ h.p. motor is fitted, and this rotates a perforated cylinder of white maple in a tank of sudsey water 44 times per minute. By the use of a patented segment gear, pitman, crank and shaft the cylinder is rotated 22 times in each direction per minute, i.e., it reverses after each revolution. There is no jar at reversal as the speed of rotation is a maximum at the middle of the stroke and gradually falls away to zero at the moment of reversal. Within the cylinder are several cross bars or lifters. With each revolution of the cylinder the water is forced through the clothes twice—once while they are travelling through the suds and again when dropped into the suds by gravity, after being carried up by the lifters. The

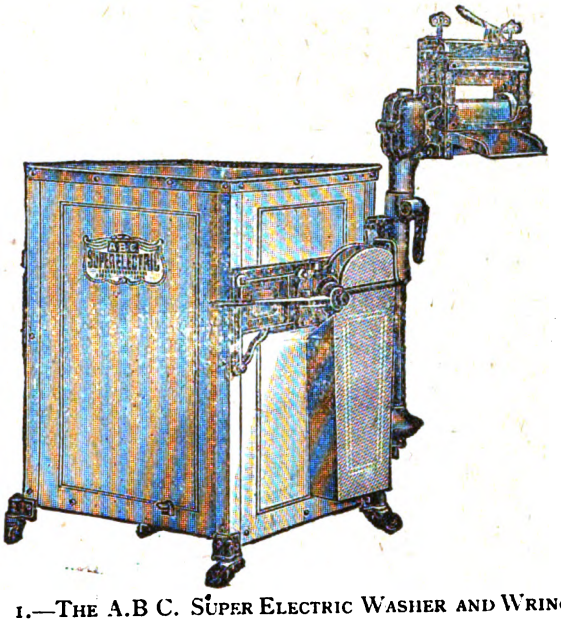


FIG. 1.—THE A.B.C. SUPER ELECTRIC WASHER AND WRINGER.

suds are forced through the perforations in the cylinder, and the dirt passes out the same way, settling at the bottom of the tub. This arrangement gives the closest adaptation of the human method of washing so far devised. There is no "wadding" of the clothes, which can be put folded into the cylinder. The frame and, in fact, all parts are solidly constructed.



FIG. 2.—SEGMENT GEAR.

The reversing wringer can be instantly removed or set in different positions; so that, if the machine be set in the correct relative position to two sinks or tubs and the clothes basket, the clothes can be washed, passed through the wringer and the first rinsing water, again through the wringer to the second rinsing water and finally direct into the basket. An instantaneously operating quick release is provided in case of a jamb. It can be operated at the same time as the cylinder, as there is plenty of

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power, which is transmitted to both cylinder and wringer through a special V-shaped corded rubber belt drive. This takes up the jar and strain caused by overcoming the interia at the start, insulates the machine from the motor and acts as a safety device, by slipping, should an excessive strain be set up. The arrangements further permit of easy adjustment of the tension by means of a thumb-screw, or the motor may be detached for use with other labour-saving devices. The size of the complete machine is 2 ft. 6 in. wide by 4 ft. 3 in. to top of wringer, and a detachable wooden top can be fitted to convert the machine into a table when not in use for washing. Control of the motor is by push buttons. Further, by removing the wringer an ironer can be attached, making the machine into a "complete electric laundress."

One other point should be mentioned. It is concerning the cost. It is known that the hire-purchase system with regard to pianos, sewing machines, furniture, etc., is very popular, but the enormous extent to which it is indulged in by people of *all* classes is not always appreciated. However, so convinced of its popularity is the Sun Co., that it has arranged convenient terms of purchase by the public through the retailers, and we commend the machine and the terms of purchase to all retailers and would advise their obtaining full particulars from the Company. A model laundry has been fitted up at the enlarged Charing Cross Road premises, where the machine is demonstrated.

AIRE AND CALDER ELECTRICITY DISTRICT.

The inquiry into the proposed Aire and Calder Electricity District has just been held at Leeds. The sitting lasted nine days. The area embraces the districts controlled by the local authorities between the River Wharfe on the north, Burnley on the south, Tadcaster on the east and the County boundaries. There are three schemes proposed:—(1) The Leeds Corporation scheme, (2) the Conference of Local Authorities scheme, with the Bradford Corporation at the head, and (3) the Y.E.P. Company's scheme. There was a big array of counsel and technical and financial experts. Mr. E. Wooll, K.C., led for Leeds Corporation, Mr. A. T. Millar, K.C., for the Conference of Local Authorities, including Bradford, Mr. Hunter Gray, K.C., for the Power Company, and Mr. J. A. Greene for the population of 750,000 in the Rural Districts of the West Riding.

The submission of the case for the Leeds Corporation occupied practically three days and, in opening it, Mr. Wooll admitted that their scheme had not received substantial support outside the City. They wished to encourage efficient autonomy and to avoid large capital commitments. He contended that it was not practicable, owing to the difficulty of finding adequate coaling resources, to have one super-generating station, and said it was proposed, he said, to set up stations at Leeds, Wakefield and Knottingley.

Mr. C. Nelson Hefford, chief electrical engineer to the Leeds Corporation, gave evidence at great length in support of the scheme submitted, and said that the proposed site of the Leeds station was on 6½ acres of land in South Accommodation Road, on the banks of the River Aire. Speaking on the financial aspects, he estimated the cost of the scheme to the corporation at about six million pounds in 1925, ten millions in 1930, and about seventeen and a half millions in 1935.

Replying to Mr. A. T. Millar, K.C., he admitted that the scheme might be carried out later more cheaply than at present.

Replying in re-examination to a criticism by the Chairman of the site selected and purchased by the Leeds Corporation, witness said that if it was considered inadequate thirty or forty acres at Knostrop, near the Sewage Works, were available.

With regard to the cost of electricity, he said he estimated that in 1935 it would be possible to supply it at 1½d. per unit.

The Town Clerk of Leeds (Sir Robert Fox) and Mr. Arthur Collings, City Treasurer of Birmingham, also gave evidence supporting the scheme.

In opening the case on behalf of the Conference of Local Authorities, Mr. A. T. Millar, K.C., said their scheme was not by any means a parochial or local one. It was not a Bradford scheme but was propounded and supported by a large number of important and successful local authorities, of which Bradford was one. It appeared to him that the three solutions proposed appeared to be arranged in a rising scheme of evolution, but he urged that the Conference scheme was one for public ownership and control of electricity throughout the area concerned. In the course of his lengthy address he referred to the fact that Leeds was "ploughing its own furrow," whereas, he said, the authorities he represented were competent and experienced municipalities advised by several experts. They were confident that if they took over the whole area they would have no difficulty in arriving at a reasonable adjustment with neighbouring areas which were not included in their boundaries. The scheme he put forward was for public ownership and public control instead of for private ownership and control, and was supported by all the local authorities except Leeds.

After Alderman Wilfred Turner, Chairman of the Bradford Electricity Committee, had given evidence in support of the scheme, he admitted, in cross-examination by Mr. Wooll, that resolutions of approval had only been received from nine of the sixteen boroughs in the area concerned, and that there was an element of compulsion in the proposals to acquire the Yorkshire Electric Power Company's undertakings.

Mr. Millar, however, said it was the intention of the authorities propounding the scheme which he represented to obtain an agreement from the Yorkshire Electric Power Company enabling the scheme to go forward, which it could not do unless some such agreement was previously arrived at.

Mr. Hunter Gray, K.C., in opening the case for the Power Company's scheme, stated that their attitude was absolutely the opposite of obstructive, but if they had to choose between being bought out at a fair price and being starved out of existence, as had been suggested in the Leeds scheme, they would, of course, choose the former. He submitted that the Company could itself undertake the responsibility of a joint authority. Alternatively it had prepared plans and could go on under its present powers and could supply those districts in which there were no authorised distributors. Thirdly, although its powers were not wide enough, it could continue under them. Mr. W. B. Woodhouse, the Company's engineer and general manager, then gave evidence, and in its course referred to the fact that out of 63 undertakings the Company had made arrangements with 40, and was in negotiation with several others. If left alone there was every prospect of a settlement of the whole problem in a year or two. With the assistance of the generating stations at Bradford and Leeds (Leeds strongly objects to acquisition by the Power Company and "is determined to retain control of its own generating stations") the Company could supply the whole of the electricity required in the area from its Ferrybridge station, where plant of 135,000 kw. capacity would be installed. Other evidence in support was given and, on behalf of the West Riding County Council, it was stated that that body was able to support either the Leeds or the "Conference" scheme.

Finsbury Technical College.—The entrance examination for the session 1921-22 will be held on Tuesday, September 20 next. Applications for admission should be forwarded to the College not later than September 15 on forms to be obtained from the Registrar, Leonard Street, City Road, E.C. 2.

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ARTIFICIAL LIGHT AS AN AID TO GAMES AND SPORTS.

At the annual meeting of the Illuminating Engineering Society, on May 31, the usual report of the Council was presented, after which a discussion on the use of artificial light as an aid to various games and sports was read by Mr. J. S. Dow. As usual, Mr. Gaster, in presenting the annual report, was able to present a record of much useful and varied work. New committees dealing with Photometry, Motor Headlights, and the Lighting of Kinema Studios have been formed, and an encouraging feature is the gradual resumption of international co-operation in connection with illumination.

Mr. Dow, in his introductory paper, pointed out that the use of artificial light for games is a wide subject and that only the fringe of it has been touched as yet. We must look to the future when the present period of abnormal economy has passed away and the various difficult problems involved have received close and careful study. A distinction was drawn between sports and exercises and games which involve following the flight of a ball. The former present relatively simple problems. The lighting of drill halls, gymnasiums, etc., is best effected by well-distributed lights in proper reflectors mounted high up, leaving the room as a whole quite clear for operations. In ball games, however, conditions of background, shadow and contrast play an important part.

Reference was made first to various games that involve a considerable playing area and are generally regarded as essentially out-door pastimes. Mr. Dow remarked that artificial light had been occasionally used for football matches. This did not appear a very difficult technical problem as a football was a relatively large object, moving at a small speed in comparison with that of balls at tennis, hockey, cricket and other games. Lamps should be spaced on high posts, preferably 30-40 feet high round the playing area. Some light should be allowed to pass upwards and illuminate the ball when kicked to a height, and the ball should preferably be light in colour so as to be easily visible against the sky as a dark background; lights should, however, be so shaded as to cause as little inconvenience as possible to players and spectators in the form of glare. Lamps would have to be protected as far as possible against impacts of the ball, but the expense involved in occasional breakages of lamps would probably not be very serious. In the case of important clubs which received considerable revenue from gate-money, the cost of such lighting would probably not form a very troublesome item. In hockey the conditions are generally similar to those for football, but the ball travels mainly on the ground. On the other hand, its greater speed and smaller size would involve more careful lighting. In both cases there should be special local illumination over the goals.

Golf links and cricket grounds offer the most difficult problems, owing mainly to the large area to be lighted. Mr. Dow, however, suggested that the difficulties were not insuperable, and that even if the lighting of an entire ground was found impracticable it would not be difficult to arrange for the artificial lighting of practice putting greens and cricket pitches, if necessary under cover, for winter play. He described the successful lighting of a golf putting ground at New Jersey, and recalled that a base-ball ground in Chicago had been lighted artificially some years ago, and that football and lacrosse had also been played on this ground at night time without difficulty.

Other outdoor games, such as bowls and croquet, seemed well adapted to artificial lighting, as the balls travelled exclusively on the ground and the area to be lighted was not large. There were records of bowls matches being finished in emergencies by improvised acetylene lighting, and the conditions could naturally be made more perfect if permanent lighting were installed.

Passing on to games played either out of doors or under cover, Mr. Dow described the lighting of squash racquets courts, which had frequently been undertaken, apparently with complete success. The white walls played a useful part in diffusing the light and the cost of lighting had been only 2d.-3d. an hour per court, which was a very moderate sum. Outdoor tennis courts in New Jersey had also been lighted artificially at moderate expense and with fair success. There were in London and other cities a number of instances of covered lawn tennis courts, with a wood surface, where artificial light was used, notable instances being the Queen's Club in West Kensington and the Covered Courts at Dulwich. The plan adopted in such cases was to avoid overhead lights which were apt to prove troublesome to a player looking upwards, and to space the lights in appropriate reflectors round the sides of the court, sometimes with special local overhead lighting over the back lines in order to enable the server to be clearly seen. Results had been quite encouraging though there were certain difficulties still to be overcome. It was customary to adopt white balls and dark surfaces for court and surroundings, in accordance with conditions applying out of doors. A dark wood surface tended to become polished by the friction of the feet of players and inconvenient reflections of surrounding lights were apt to be seen. Although it might seem to players a somewhat radical departure, Mr. Dow pointed out that the use of dark balls and a white surface for the court and surroundings was much more favourable to successful artificial lighting, and would do much to remove the difficulties arising from polished reflection, referred to above. Generally speaking, the aim would be to use concealed sources of light and reflection from light-diffusing surfaces. The lighting in the court at the Palace of the King of Sweden at Stockholm was said to be very good; in this case lamps mounted above a diffusing glass ceiling were used.

In conclusion, Mr. Dow briefly referred to the lighting conditions desirable for various indoor games, such as billiards, chess and card play. In view of the fact that games played such an important part in the national life of this country, and that the period of daylight available was so restricted in winter, the use of artificial light appeared well worth consideration.

MORE ABOUT BOILER BREAKDOWNS.

By H. S. B. ROBINSON.

Having dealt largely in a previous article with those breakdowns arising from corrosion, low water and cold water, it is proposed to discuss those faults which, unless properly cared for, would seriously affect the efficiency of the boiler and at the same time expensive delays would be almost certain to result.

Foaming.—The carrying over of water mechanically mixed with the steam is a fault frequently met with in steam boilers. The water not only carries away heat without any useful effect, but when present in any marked quantity itself becomes a source of danger and of serious loss in the engine. If steam rises from a surface of water faster than about three feet per second, it carries water with it in the form of spray, which is a fact that should not be lost sight of. Many boilers show a high apparent evaporation in consequence of furnishing wet steam, while practically they must be considered anything but economical. The cause of priming may be attributed to either impure water, too much water or improper proportions in the boiler. When a boiler is found to form wet steam with good water carried at a proper height it is generally a proof of wrong design, but, of course, the amount of priming in different boilers will vary considerably. Foaming, however, may usually be stopped by checking the outflow of steam, but if caused by dirty water, blowing down and pumping up will generally cure it, though in cases of violent foaming it will be necessary to check the fires and draught. It should be mentioned that iron stacks are better than brick chimneys, because there is no infiltration of air as through brickwork. Round chimneys are unquestionably better than square,

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and a straight flue better than a tapering one, though it may be larger or smaller at the top without having any injurious effect.

Circulation.—General lack of circulation of the water in boilers is a frequent and prolific cause of unequal expansion and deteriorating strains, in addition to which the tendency to deposit sediment on the heating surface increases rather than diminishes. It will be seen, therefore, that the matter of rapid circulation becomes one of vital importance.

Standing Unused.—When a boiler is not required for some time, it should be emptied and dried thoroughly, but if this is not possible it should be filled quite full of water and a quantity of common washing soda added, after which the external parts exposed to dampness should receive a coating of linseed oil.

Rapid Firing.—In boilers with thick plates or seams exposed to the fire, steam should be raised slowly, and rapid or intense firing avoided. With thin water tubes, however, and adequate water circulation, no damage can come from that cause, although it is never economy to force a boiler, and the best results are always obtained with ample boiler power. It is hardly necessary to say that no surface which requires to be "stayed" should be permitted in any boiler, as it is scarcely possible and altogether improbable that such "stays" are or can be so adjusted as to bear equal strains. The one sustaining the heaviest strain gives way, the others follow automatically, and an explosion is likely to occur at any moment.

Coverings.—The losses by radiation from unclothed pipes containing steam are considerable, and in the case of pipes leading to steam engines are magnified by the action of the condensed water in the cylinder. It is therefore important that such pipes should be well protected, but there is a wide difference in the value of different substances for protection from radiation. A smooth or polished surface is of itself a good protection, but hair or wool felt has the disadvantage of becoming soon charred from the heat of steam at high pressure, and sometimes takes fire therefrom.

A variety of "cements" have been used for covering pipes, composed generally of clay mixed with different substances, such as asbestos, paper fibre, etc., but cork chips cemented together with water-glass undoubtedly make one of the best coverings known. A cheap jacketing for steam pipes, but a very efficient one, consists of laying strips of wood lengthways and binding them in position with wire or cord, and around the framework thus constructed roofing paper should be wrapped and fastened by twine or paste. For flanged pipes, space may be left for access to the bolts, which space should be filled in with felt. If exposed to the weather, tarred paper may be used or the exterior painted, either of which would prove entirely satisfactory.

THE LONG-DISTANCE TELEPHONE SYSTEM OF THE UNITED KINGDOM.*

By Sir William Noble, M.I.E.E.

(*Concluded from page 306.*)

The Chairman (Mr. J. S. Highfield), in calling upon Mr. F. Gill to speak, reminded his audience that Mr. Gill had been the Chief Engineer to the National Telephone Company, and had had the pleasure—some people said it was a mistake—of selling his Company to the Post Office.

Mr. F. Gill said he would like to pay a tribute of admiration to the work done by the Post Office Engineering Staff. He would like to give a picture of the conditions in dealing with telephonic communication over distances by various methods, in order to show the degree of improvement that had taken place. On his first slide was shown the amount of copper required for telephonic communication over 500 miles with overhead wires, with plain underground wires, with underground wires loaded, and with underground wires with repeaters in tandem. From these curves it would be seen that two things had been accomplished. The first was that a very great improvement had been made in the amount of copper required, and secondly, very much larger distances could be covered than were possible before. To carry 500 circuits overhead would require something like 10 routes, and he doubted whether sufficient space could be found in the country for them, whereas for the same number of circuits only 10 pipes would be required underground under modern conditions of a 4-wire circuit with repeaters. In the U.S. there was at present in commercial service carrier circuits for telephony and telegraphy, i.e., high frequency from wire to wire, in use up to 3,500 miles of physical circuit, and these carriers were providing for 19,000 miles of extra channels, some telegraph and some telephone. There was such a circuit between New York and Chicago, a distance of 742 miles, in which there were four intermediate repeater stations. At the first repeater station only the carrier current was repeated, at the second repeater station both the carrier and the voice was repeated, at the third station the carrier was repeated again, and the voice broke off and continued on another line. At the next station the same thing happened, the voice broke off, the carrier was repeated, and recommenced on another line. This carrier system had been applied successfully commercially, and had fulfilled all the requirements of high-grade long-distance service. It had proved flexible, had been maintained by the ordinary personnel, and it fitted into the plant the same as any of the other circuits. The installation between Chicago and New York was one in which the carrier current itself was suppressed and did not go over the line. There were about 500 miles of that, and on the same route of poles there was another carrier telephone system for 200 miles. Finally, Mr. Gill showed a picture of the Chicago terminal of the circuit, showing that the apparatus was on engineering lines, and far beyond the string and glue stage.

Mr. G. C. Marris pointed out that the transformer must be considered in conjunction with the valve, and he considered that both valve and transformer could be improved if considered as one problem. Even so, he would like to emphasise the point that the valve as a telephone repeater had been put to far more refined use and pushed to further limits of uniform behaviour than in any other of the applications of the valve.

Mr. E. H. Shaughnessy expressed the hope that Continental people could be persuaded to develop underground loaded circuits, in order that there could be continuous equipment of this nature between London and Paris or London and Brussels, similar to that contemplated between London and Liverpool and the big commercial centres. He thought in this country it was important to realise that the trunk system should be completely underground, and not partly underground and partly overhead, and in this connection he would like to know the difference in capital costs and annual charges of a complete underground system compared with an equivalent service overhead.

Sir William Noble, briefly replying to the discussion, said that he had investigated oxide-coated filaments, but did not deal with them in the paper because he had not set out to deal with the thermionic valve in detail. He did not see any reason why we should not be speaking to New York at no distant date. As to development studies, they were on a no-delay basis, because experience had shown that when the public was provided with lines which did not go out of order, more revenue was obtained from them. That had been shown in the case of the London-Liverpool line, and he was quite certain that when all the underground circuits were laid the Post Office would get considerably more revenue. The improvement effected by repeaters was shown by the fact that between London and Manchester 240 circuits could be got into one pipe, compared with only 36 without repeaters.

* Paper read recently before the Inst.E.E.

Wanted.—A reader, Mr. Geo. Allen, Parkhead, St. Dennis, Cornwall, wishes to have particulars of small water motors giving about 3 h.p. to work from a ¼in. nozzle at about 60 lbs. pressure per sq. ft. He will be pleased if any reader can put him in touch with the manufacturers of such machines.

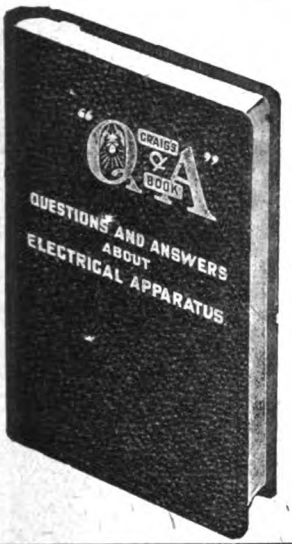
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Current Topics.

"Victimisation"—Unconscious Humour.

Really there is a fund of humour underlying the present-day tragedy of extreme trades unionism. Thus, the Glasgow dockers recently passed a resolution agreeing to resume work at once on condition that there is complete reinstatement of the men on strike, *no victimisation*, and complete clear out of the non-union labour at the docks. The humorous aspect of these conditions will be obvious to every intelligent reader. If refusal of the right to work to non-union labour by unionist labour is not victimisation of one section by the other, then I should like to know by what other term one could rightly describe it. In effect, the final condition is a direct parody of the penultimate one, and it is curious, to say the least of it, that the unionist dictators did not tumble to the fact that they were making themselves a laughing-stock.

The dominant trades unionist too often overlooks the fact that there are two sides to every so-called "dispute." This is nominally, at all events, a free country, and every worker has a perfect right to decide for himself whether he shall or shall not join the ranks of trades unionism. I have no quarrel with trades unionism in principle, but I do maintain that its extreme actions of the past few months have abundantly demonstrated that the extremist minority rule has overstepped the bounds and brought the movement into disrepute. The voice of trades unionism to-day talks of a capitalist campaign to cut wages. Nothing of the kind; it is sheer common-sense which dictates the necessity for lower wages. We cannot compete in the world's markets to-day; our goods are too dear by comparison with the foreign products; why?

Labour, in the shape of wages paid for work done, bulks largely in practically every manufactured product. Any shopkeeper will tell you why he has to charge you more for the goods you used to buy before the war for about a third what you have to pay to-day. It's all in the labour put into the article, and paid for at current inflated rates. I paid for a hat for the predominant partner the other day, and had quite a friendly discussion with the saleswoman on the subject of its price. I pointed out, and she had to agree, that the raw materials analysed down were only a very small fractional percentage of the sale value of that headgear. But, has she pointed out, it's the *labour* of making it and the ridiculous wages the trade has to pay for that labour which make the article so costly.

To give him his due, the older and saner element of the working community fully recognises the facts, and looks forward with longing to the day when wages, together with the cost of living, which is closely correlated with wages, will assume more normal proportions. It is no good receiving an extra pound or two a week if you are out of work half the time through slackness of trade directly arising out of the consequent high cost of the articles you are helping to make. It is surely preferable to be regularly employed at a lower and reasonable wage and to see every other worker similarly occupied. In this connection the vicious system of "doles" for unemployed has sapped the morale of the worker to an unprecedented degree.

Sport and Artificial Illumination.

I am a firm believer in the efficacy of all sport and games to furnish us with the necessary recreation and relaxation from the eternal grind of bread and butter earning during the best hours of the day. Unfortunately the available hours of daylight for most workers to devote to recreation are all too brief, and, although the splendid daylight saving scheme has enormously augmented our play hours during the summer months, we should welcome a further extension of the period during which such healthful relaxations as cricket, football, tennis, golf, hockey, and the like, could be indulged in. As a nation we are prone to spend too much time in the cinema, music hall, and other amusement centres where the form of recreation is sedentary and therefore harmful when indulged in to excess.

Dancing is different, inasmuch as it is a form of healthy exercise even if taken within four walls, and in all these indoor recreations the question of illumination presents no difficulties. Where outdoor sports and games are concerned, the problem is different, and it is questionable how far artificial lighting can help us in overcoming the daylight disappearance at an earlier hour as the summer passes. An interesting paper on the subject was read before the Illuminating Engineering Society by Mr. J. S. Dow, who pointed out that the consumption of electricity necessary to effectively light a football ground should not prove excessive where there was ample revenue from gate-money. A football, being a relatively large object, and its movement slow, the technical requirements of the lighting to ensure a good game by artificial light would not appear severe. Lamps would have to be mounted

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round the field at heights of 30 to 40 ft., so as to leave a clear space and at the same time avoid damage by impact from the ball.

In the case of hockey, the fact that the ball was white and travelled mainly along the ground, rendered its movements easier to follow in spite of the greater speed of movement. Cricket offers greater difficulties owing to the larger area, and there would necessarily have to be powerful local illumination of the wickets, possibly accentuated by white batting screens acting as reflectors. In the case of a golf links the aim would presumably be to provide moderately even illumination by well screened lights over the fairway, and higher local illumination over the putting greens, bunkers, etc. Mr. Dow added that he understood the lighting of a complete golf links had already been seriously considered in the United States, as had also the illumination of baseball matches and other American games played after nightfall.

When the Supply Fails.

It says much for the general reliability of electricity supply in this country that when the current does fail as has happened in one or two instances lately, due to coal shortage and contributory causes, we lose sight of the possible consequences, with oft-times amusing results. An example is reported from Birmingham where the shutting off of the supply on a recent Monday afternoon, after due warning to consumers, found a portly and respectable business man suspended in the lift cage, midway between two floors of his office building. He was not alone in his dilemma, being accompanied by the lift attendant, a young lady of considerable personal charm. Rumour has it that the gentleman's wife, tired of waiting for her spouse, risked the staircase, and learning of the denouement, insisted that the power station should be communicated with and the current switched on for a sufficient period to enable her to recover her lord and master.

The incident reminds me of a similar happening during the coal strike of pre-war days when the staff at a certain provincial power station were persuaded to relinquish their duties without due warning. I happened to be in an electric lift at a local works, just at the instant they downed tools and the turbos were switched off. We were between floors, but fortunately the disparity of levels was small, and after the gates had been opened I was able to climb out without difficulty. There is this comforting reflection in connection with unexpected failure of electricity supply, that it does not involve such possible dangers to the consumer as does interruption and subsequent resumption of the supply of gas, where taps are left turned on in ignorance of the fact that jets had been left burning.

ELEKTRON.

Losses on Trams.—At the Colne T.C. meeting on June 1, Mr. J. Thompson, chairman of the Electricity Committee, said that if they could get chars-a-bancs prices on the cars, they could make a profit.——The remedies suggested for the falling off in profits at Blackpool are the abolition of discount tickets, 50 per cent. increase in contract (season) tickets, fare on Layton route increased to 1½d. and revision of fares between Blackpool and Fleetwood. Contracts costing £3 will be raised to £4 10s. Aberdeen is the only other place in Great Britain where tram contract tickets are issued.

SHOP WINDOW LIGHTING BY GASFILLED LAMPS.

The intensity of illumination required for shop window displays varies from 15 to 25-foot candles, according to the colour and nature of the goods exhibited, the lower figures being for light surroundings and open dressing. With modern reflectors and lamps these values can be obtained with a current consumption of from 1 to 3 watts per cubic foot of window space. The 40, 60 and 100 watt gasfilled lamps are particularly suited for shop window illumination.

The type of reflectors used, and their arrangement, will depend very largely on the size of the windows. A large window such as those in the big department stores should be treated, for lighting purposes, as a small theatre stage. For these windows trough reflectors give excellent results. A typical trough reflector designed by the General Electric Co., Ltd., is shown in Fig. 1 This consists of a steel shell lined with mirror glass strips and provided at suitable intervals with B.C. holders to take 100-watt gasfilled lamps. The design illustrated is intended for use in windows of average depth and the lamps are spaced 18 in. apart. Other types are available for windows of various proportions, and different spacings can be arranged so that the correct number of lamps and accurate distribution of light can be provided in any situation.

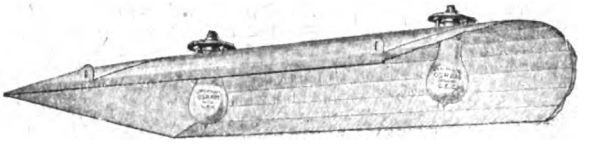


FIG. 1.

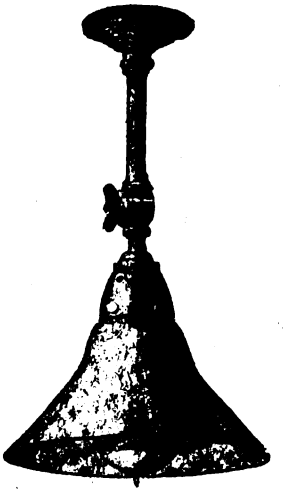


FIG. 2.



FIG 3.

Where the window dressing is likely to vary in character from week to week or where a very flexible system of lighting is desired, the G.E.C. F.B.323 individual unit, shown in Fig. 2, is of considerable use. This unit consists of a concentrating type steel reflector lined with mirror glass, mounted on a knuckle-jointed brass down-rod and provided with a ceiling plate and B.C. holder. This fitting can be adopted as a pendant or bracket and is intended for 60 or 100-watt gasfilled lamps, special ventilation being provided. With suitable switching arrangements, a variety of lighting effects can be obtained and the adjustable joint allows the light to be directed where it is most needed.

Both the trough reflectors and the individual units are carefully designed to screen the lamp filaments from direct view. It occasionally happens, however, that it is impossible to arrange that the lamps are invisible to customers in the porches or arcades. The judicious use of hangings, however, will often minimise this trouble.

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In lighting the windows of the smaller shops, the illuminating engineer meets several difficulties, the small shopkeeper often being averse to incurring the expense. Moreover, until recently, there have been practically no simple yet scientifically-designed units available at a reasonable price. The unit shown in Fig. 2 is well suited for small shops, but where expense is a great consideration, the reflector, holder and gallery can be supplied with a short length of flex and a B.C. adapter for attachment to existing pendant points. Fig. 3 shows a similar unit equipped with a G.E.C. "Superlux" shade. "Superlux" is a white "cased" glass having an "eggshell" finish, and combines good diffusing and reflecting properties with a low absorption factor. By the use of suitable curtains or friezes, the individual units can be completely hidden from public view and the effects obtainable are a most welcome contrast to the alternate sickly and glaring results seen in shops where no attempt at scientific illumination is made.

We understand that the General Electric Co., Ltd. (Magnet House, Kingsway, W.C.2), have specialised in shop window lighting and that, although they do not carry out installation work, their illuminating engineering department will willingly give the benefit of their experience by way of advice to those interested in lighting problems.

THE ELECTRICAL EQUIPMENT OF THE EASINGTON COLLIERY.

Close to the village of Easington, Co. Durham, is situated the extensive colliery undertaking of the Easington Coal Co., Ltd. Two main shafts have been sunk, the north and the south, and when working the total daily output of the combined pits amounts to 3,000 tons. Being a comparatively modern venture it is only natural that considerable use is made of electric power, and the main object of this article is to describe, first, a large electrically driven ventilating fan, recently installed at the colliery, and secondly, the underground system of electric haulages. As regards the latter, few collieries are so well equipped for rapid and efficient transport of coal below ground.

The main winding engine is steam driven, the exhaust steam being supplied to a 350 k.w. mixed pressure turbo-alternator. In addition a supply is taken from the 2,750-volt, 40 cycle mains of the Cleveland and Durham Power Co. The full voltage is applied to the terminals of the larger motors, while a part of the supply is transformed to 440 volts for the smaller motors. Originally the pits were ventilated by a steam driven fan, but more recently a new type "Sirocco" double inlet fan driven by an 800 h.p.

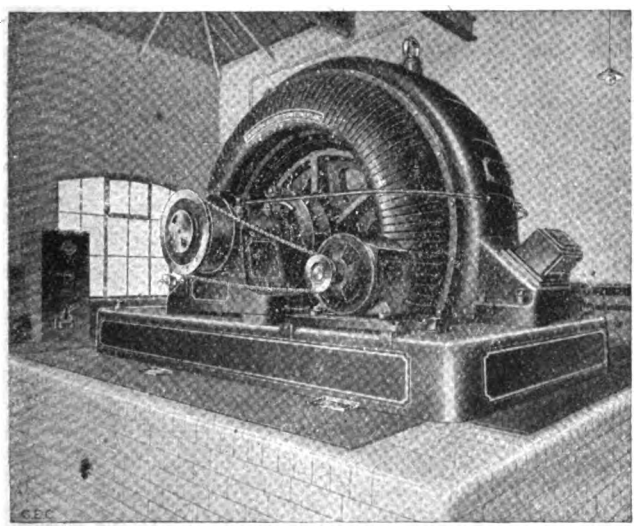


FIG. 1.—END VIEW OF 800 H.P. FAN MOTOR, SHOWING EXCITER FOR "KAPP" PHASE-ADVANCER.

"Witton" slip-ring induction motor was installed. A certain amount of direct current is required, and two 120 k.w. G.E.C. rotary converters have been installed to meet this need.

The fan, which was supplied by Davidson and Co., Ltd., of Belfast, has a capacity of 500,000 cub. ft. of air per min., with a water gauge of 6 in. The diameter of the fan is 133 in., that of the suction inlets 148 in., and the equivalent orifice of the mine 82 sq. ft. The driving power is transmitted from the motor to the fan through double helical gearing fitted with forced lubrication, the speed of the motor being 294 r.p.m. and that of the fan 198 r.p.m. In order to maintain a power factor which shall be practically unity a "Kapp" phase-advancer has been supplied for connection to the motor. Views of the motor are shown in Fig. 1, and of the phase-advancer, motor control panel, and phase-advancer control panel in Fig. 2.

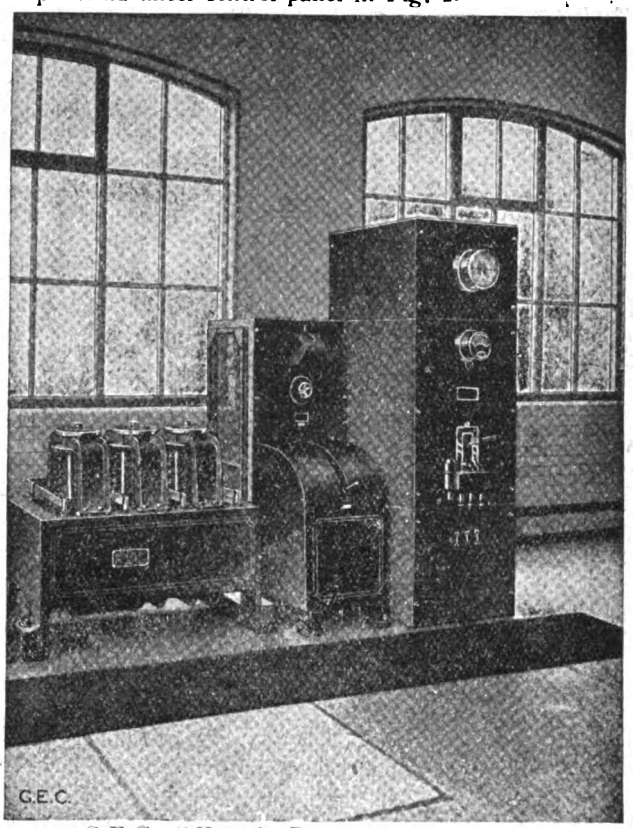


FIG. 2.—G.E.C. "KAPP" PHASE-ADVANCER AND CONTROL GEAR FOR FAN MOTOR.

The haulage gears comprise two large main-and-tail haulages of 600 h.p. and 450 h.p. respectively and three endless haulages, two of which are of 160 h.p. and the third of 85 h.p. All are driven by G.E.C. "Witton" motors. There are in addition several small oscillating engines which feed the main haulages from the various landings.

(To be continued.)

Accrington.—The loss of £12,584 on the Electricity undertaking last year, and £3,175 on the tramways, has caused much surprise. The loss on the former is the heaviest recorded. Added to £21,724 borne by rates in former years, and treated as a debt due to rate funds, the total loss is £34,578. The apparent cause is failure to increase charges at the appropriate time. Management and general expenses have risen from £1,781 to £2,745, distribution from £3,580 to £5,017. The largest increase was in the cost of generation, which rose from £35,590 in 1919-20 to £61,225 in 1920-21, a jump of £25,635. The sale of current realised £76,555, against £53,685. The generation and distribution of electricity cost £62,242. When provision is made for £7,096 interest on loans and £6,936 for sinking fund, there is a loss on the year of £8,801.

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UNDERGROUND HAULAGE BELLS AND TELEPHONES: TROUBLES AND THEIR REMEDIES.*

BY J. S. KENDAL.

No apology is necessary for bringing forward a subject of such widespread application as the use of electrical signalling apparatus for haulage work in mines. It is a part of the electrical work which has been sadly neglected, and one may even find colliery electricians who regard pit bells as beneath their notice or too trivial a matter to trouble about. However, when it is remembered that the output of a mine depends largely upon the safe and regular working of the haulage system, it is obvious that the subject really is of some importance, in most instances equally as is the working of the haulage engine or motor. If a haulage motor breaks down the working of that part of the mine with which it deals is disorganised and similar interruption occurs when the signalling apparatus is out of commission. In this paper the author has endeavoured to enumerate the most probable sources of trouble met with in engine-plane signalling systems.

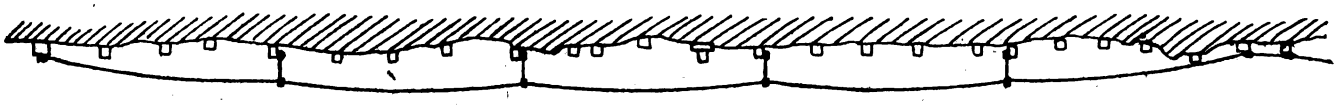


FIG. 1.

INSTALLATION AND MAINTENANCE.

At the outset it may be as well to state that a great deal depends upon the manner in which such systems are installed, more especially in respect of the housing of bells and telephones and the methods adopted for the detail wiring. Too often do we see bell stations with a collection of wires somewhat resembling a spider's web and more often a tangle which requires a good deal of sorting out in order to find any specified wire. It is almost impossible for such a system to give good results as it opens the way to numerous faults. All small wiring should be run on small cleat insulators, or in tubing or other protection where necessary, and on no account should staples be used. Wiring should preferably be vulcanised india-rubber covered; gutta-percha is liable to crack and dry, and small lead-covered wire is usually a failure for this work. Signalling stations should be constructed with brick walls wherever practicable and roofed in to prevent falls, as even quite a small stone falling may damage a bell-gong, for instance.

Signalling lines are usually of galvanised iron wire of sizes 11 to 8, run on insulators attached to the roof or timber of the roadways. In dry places ordinary bobbin or pit insulators may be used, but in wet places mushroom shackles or similar insulators with a drip petticoat are advisable in order to prevent leakage. In very wet places where it is required to run bare wires, a good plan is to fix them in comparatively short lengths shackled at each end and supported at intervals by hangers as shown in Figs. 1 and 1a. Bare wires, however, can usually be dispensed with, and it is better to use insulated wires secured to insulators by strong cord, or to use a small cable such as 2, 3 or 4-core, supported by tarred rope slings. In wet seams it is advisable to keep the line voltage low in order to reduce leakage, and this may be done by using relays to ring the bells through a local battery; also by using the larger sized wires, say, No. 8, which, in addition to reducing the voltage drop, is better suited to resist the corrosive effect of the water, and will therefore have a longer life. It may be mentioned that even where the roof is dry but the floor of the roadway is wet, the lines should be strong and very securely supported, as cases have been known where they have been pulled down by workmen using them as a sort of handrail or lifeline in order to steady themselves and avoid slipping into the water whilst walking along the rails. Where possible, bare wires should be spaced sufficiently far apart to prevent accidental contact and twisting.

In many haulage systems it is often a difficult matter to arrange bare wires around curves and at junctions, more especially where the haulage ropes are overhead and liable to foul the wires. In such cases it is better to use insulated wires or a short length of cable around the curve. Lines should be broken at each station and junction and shackled off on either side, being bridged over if required. This greatly facilitates the localisation of faults, and even on long straight roads it is sometimes advisable to make off about every two or three hundred yards so that, in the event of a fall or the derailment of a set, a saving of time is effected in repairing. Of course, it is not suggested that this plan should be followed on a road having brick walls or a good roof owing to the additional number of points involved, but where there is a bad roof and falls are perhaps of frequent occurrence, these joints are a secondary consideration and the extra convenience is often well worth the initial trouble.

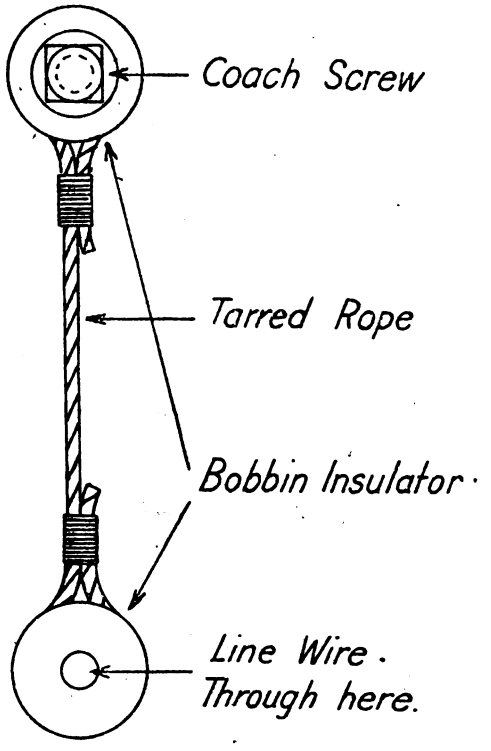


FIG. 1a.

(To be continued.)

* Paper read December 18th, 1920, before the North of England Branch of the Association of Mining Electrical Engineers.

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ELECTRICITY IN MESOPOTAMIA.
OPPORTUNITIES FOR BUSINESS.

The British occupation of Mesopotamia has been responsible for the introduction of electricity, generating plants being erected at Bassorah and Baghdad. We are now given to understand by the Bureau of Commerce and Industries, Ltd. (11, Poultry, Cheapside, E.C.2), that these stations will shortly be taken over by the Municipalities.

The chief demand will be for house lighting and for fans. Simple cheap fittings for one, two or three lights, and low-priced ceiling and table fans, together with switches, wires and cables only will be required. As no stocks are held in the country the necessary equipments must be complete in all details. The pressure at Baghdad is, we believe, 220 volts, and elsewhere 200. The wiring system mostly used in Government offices to date is the open cleat system, but occasionally casing and capping is used. It should be noted that it is desirable that the insulation should withstand the action of saltpetre. It is estimated that there should be required per annum some Rs. 200,000 worth of electrical goods.

G.E.C. ROTARY CONVERTERS.

The general principles involved in the theory and design of rotary converters are briefly but lucidly described in the second edition of Bulletin No. 9, published just recently by the General Electric Co., Ltd. (Magnet House, Kingsway, W.C.2). Special attention is given to armature heating and voltage regulation. A section is devoted to the subject of starting and synchronising, including the simple G.E.C. method of self-synchronising, in which there are three operations:—(1) The rotary is started by closing a switch in the starting motor circuit; (2) when the rotary has excited itself and gives 100/150 volts, current is switched on to the rotary through reactances by pushing a main switch into a preliminary pair of contacts; (3) the main switch is pushed home, short-circuiting the reactances and tripping the starting motor. Connections are given for this as well as for the G.E.C. method of running rotaries in parallel. Another feature deserving of mention is that a section is devoted to notes and diagrams on sub-station equipment and lay-out. The publication runs to 52 pp., is well produced and enriched by a number of excellent illustrations and diagrams conveniently arranged with respect to the text.

CITY AND GUILDS OF LONDON INSTITUTE.
REPORT OF THE COUNCIL.

The City and Guilds Report for 1920, as usual, deals lucidly with the important educational work carried out at the Engineering College at South Kensington and at the Finsbury Technical College, considerable space being devoted to the negotiations which led to the latter being ensured of at least five years longer life. It is earnestly to be hoped that during that time some means will be found to continue the work of this pioneer institution, which, especially in the earlier days of the industry, gave such a liberal engineering education that it enabled many of the leading engineering appointments throughout the world to be secured by its students. The matter was suitably referred to at the Annual General Meeting of the Inst. E.E. by the President, Mr. Ll. B. Atkinson, himself an old Finsbury student. In this connection it may be remarked that the Institution Council have been largely instrumental in securing the continuance of the College.

The holder of a C. and G. Certificate in any branch obtains a hall-mark of unimpeachable value, and it is not surprising, therefore, that the total number of candidates in Technology examined at centres in the United Kingdom was 9,825, as compared with 8,523 in 1919. Noteworthy increases occurred in Telegraphy (579 candidates, as compared with 198), in Telegraphy (683 as compared with 267), and in Grade II. and Final Electrical Engineering (1,111 as compared with 407).

For the special examination in Magnetism and Electricity there was a greatly increased number of candidates, 839 having entered as compared with 268 in the previous year. Doubtless this increase is to be attributed to the return of Post Office employees to their ordinary civil duties. In the First Class 353 passed, and 195 in the Second Class.

The examinations were again held at the usual centres in India, the Overseas Dominions and the Crown Colonies, with the addition of the Durban Technical College. The Department is gratified to be able to report that Sir Philip Magnus, who was previously appointed as a member of the Council of the Institute, has now become a member of the Executive Committee and of the Technology Committee. The Department is glad that it will thus be able to continue to have the benefit of his advice in the conduct of its work. No changes were made in the personnel of the Examinations Board during the session under review, but since the close of the session the Department has received with regret the resignation of Mr. J. Wilson, whom they congratulate on his appointment as an Inspector of the Board of Education.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 119.

There were some fuse boards recently served into our works. The fuse clips are fixed to iron rods insulated with what appears to be mica or micanite. I would like to know how mica is placed round the iron rods in this manner, and what material I shall require to insulate the rods if a breakdown should occur.—"CLIP."

QUESTION NO. 120.

The distance between my house and a store is two miles. I wish to rig up a signalling apparatus between them so that I can be called up at the store if I am required at the house. I do not wish to go to the expense of fitting electric bells on account of the cost of wire and the inconvenience of running them. Can I use a system of wireless? If so, please can you give me some details that will assist me?—"COHERER."

(Replies to Questions Nos. 119 and 120 must be received not later than June 25, 1921.

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NEW OVERLOAD HEAVY DUTY CIRCUIT BREAKER FOR TRACTION, Etc.

An article in a recent issue of *Kruppsche Monatshefte* describes a new circuit breaker originally developed by the Fried. Krupp A.G. for the German Navy, for use on the traversing gear of heavy armoured turrets. These were originally equipped, for simplicity's sake, with switchgear having no end-position release, and this made the gear very heavy on fuses. Automatic release gear could not be fitted to the existing controllers. The use of ordinary circuit breakers would have got over the fuse difficulty, but would still have necessitated resetting by hand.

The problem was solved as follows :—

A spring or weight holds the breaker closed when current is off. When the current reaches the predetermined limit, a solenoid excited by the main current pulls the contacts apart. At the point of break there is now the full network pressure, provided the controller is not on zero. This pressure is used to excite a locking coil, which thus only receives current when the breaker trips with the controller in the running position. When the latter is brought back to zero the current in the locking coil is interrupted, the spring closes the main contacts again and the circuit breaker is again ready for operation. Thus, when the turret came up against the buffer springs, the current rose and the breaker tripped. On the controller being reversed it automatically reset itself. No handle is necessary for the resetting of this type of breaker; it can only be reset when the circuit is broken nearer the current source, e.g., by the controller. Loose handle devices are therefore superfluous. The higher the current the greater the breaking speed.

These switches have since been developed for such uses as tramways, cranes, mine haulage and other heavy work. A magnetic arc blow-out device is fitted. An oscillograph curve shows 200 amps. at 550 volts broken in 1½ secs. inductive load with over-pressure not exceeding 200 volts.—*Technical Review.*

Various Items.

Blackburn.—The T.C., on June 2, approved a contract with the Metropolitan-Vickers Electrical Company for the installation of E.H.T. switchgear, at the Jubilee Generating Station, and with the English Electric Company for the erection of two rotary converters and switchgear.——A Sub-station is to be erected at Gorse Street for the Imperial Mill Company.

Inst.E.E. Wireless Section.—The following members have been nominated to serve on the Committee for 1920-21 :—Chairman, Dr. G. W. O. Howe; Ord. Members, Dr. W. H. Eccles, Messrs. B. Binyon, G. H. Nash and C. C. Paterson. The following will continue to serve :—Sir Chas. Bright, F.R.S.E., Prof. C. L. Fortescue, Admiral Sir H. B. Jackson, Capt. H. J. Round, Messrs. R. C. Clinker, A. Gray, A. A. C. Swinton, F.R.S., and L. B. Turner.

A Slide Rule for Students.—We are in receipt of a slide rule manufactured by J. Halden & Co., Ltd., Manchester. This is one of their standard 10 in. cardboard rules, and it appears to be very suitable for students in technical schools. It is very strongly made and will stand a great deal of rough usuage. The scales are exceptionally clear and the slide is quite a neat fit. The cursor is made of very clear celluloid, thus enabling one to easily distinguish the marks on the whole of the scales. The most remarkable feature about the rule is its price. This is only 4s. 6d. net. It is therefore within the reach of all students who do not wish to go to a large expense.

British Science Guild.—The June Journal of the British Science Guild includes among other items an article on the world position in relation to coal, by Sir Richard A. S. Redmayne, K.C.B.; a report on the utilisation of science in public departments and addresses given at the annual dinner of the Guild, by Field-Marshal Sir Wm. Robertson, Col. Sir Ronald Ross, the Very Rev. Dean Inge, the Rt. Hon. Lord Rayleigh and the Rt. Hon. Lord Bledisloe The Fifteenth Annual Meeting was held on Wed. last. On the Agenda were addresses by the Very Rev. Dean Inge on "The Road to Ruin and The Way Out," and by Sir Richard A. S. Redmayne on "The Importance of Research in Promoting the Development of the Mineral Industries." Copies of the Journal may be obtained on application to the Sec., 6, John Street, Adelphi, W.C.2.

Trade Notes.

Particulars of Helsby "Ozone Proof" Cables for 2,200 to 11,000 volts, single, concentric and 3-core, are given in leaflet H 90 issued by **British Insulated and Helsby Cables, Ltd.** (Prescot, Lancs). As vulcanized india-rubber deteriorates slowly when exposed to air, and at a much more rapid rate if ozone be present (it is developed at the surface and ends of high voltage cables), the B. I. Co., has designed a cable in which the internal and external surfaces of the vulcanised rubber are protected by a layer of special dielectric, insensible to ozone, air or copper salts. It does not reduce the flexibility of the cables.——Another leaflet, No. P 170, gives information concerning Prescot insulating varnishes, which contain, as a base, an elastic rubber-like gum manufactured only at the Co.'s Prescot Works. Included is a quick-drying black varnish, suitable for urgent repair work on electric machinery. There is also an acid-proof air-drying enamel specially suitable for accumulator rooms, etc.

The Cambridge & Paul Instrument Co., Ltd. (45, Grosvenor Place, S.W. 1), who make a feature of potentiometers, advise us that they will be pleased to send a copy of list No. 191, on this subject, to interested readers.

The Simplex Unit System of electric light fittings is briefly described and illustrated in leaflet No. 881, which has just been issued by **Simplex Conduits, Ltd.** (Garrison Lane, Birmingham). As its name implies, the system enables a large number of fittings to be built up from a small number of interchangeable component parts. Electrical installation engineers are thus enabled to maintain a comprehensive stock of fittings to meet the varied requirements of clients, with a minimum outlay and a great saving in space. We suggest that the Company should be approached for full details by all interested in the supply of fittings, as the system merits careful consideration.

The Consolidated Pneumatic Tool Co., Ltd. (of 170, Piccadilly, London, W. 1), have opened a branch office at 8, Clive Street, Calcutta, under the management of Capt. E. Grigg, where a stock of air compressors, oil engines, and portable tools, both pneumatic and electric, together with all necessary spare parts and accessories, are kept to enable customers' requirements to be immediately filled. Full particulars as to the erection and operation of this Company's well-known giant semi-diesel oil engines can also be obtained from Capt. Grigg. Messrs. G. & A. Angus of Rangoon, and Messrs. The United Engineers Ltd., of Singapore, have been appointed agents for Burma and the East Indies respectively, and they will carry stocks of the world-renowned labour-saving appliances manufactured by the Consolidated Pneumatic Too Co., Ltd., so that inquiries and orders in these areas will receive immediate and prompt attention.

The Monthly Magazine for June, recently received from **Higgs Bros.** (Sand Pits, Birmingham), keeps up its reputation for brightness, and contains, as usual, the valuable stock list. In addition, under the feature "Hints and Tips," there is a list of the approx. h.p. required to drive certain of the more commonly used machine tools. The importance of running propeller and centrifugal fans at the speeds specified by the maker is also pointed out.

At the Bath and West of England Agricultural Show just held at Bristol, **Jennings, Ltd.** (Pennywell Road, Bristol), made a full display of woodwork and joinery of all descriptions, including electric casing and capping.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

JUNE 17, 1921.

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THE ELECTRICAL EQUIPMENT OF THE EASINGTON COLLIERY.

(*Concluded from page 325.*)

The following list gives the main details of the duties which the 600 h.p. haulage has to perform:—

Length of haulage road		2,323 yards
Inclination of road.	Maximum ...	3 in. per yard
,, ,,	Round curves	1¼ in. per yard
,, ,,	Average ...	2 in. per yard
Size of rope		2½ in.
Present number of trams per journey ...		66 to 68
Weight of each tram		6¾ cwt.
Weight of coal per tram		10½ cwt.
Time taken for journey from pit bottom (at present)		12 min.
Tons of coal raised per day		1,135 tons
Working hours per day		15 hours

The whole of the mechanical equipment was supplied by Messrs. M. B. Wild and Co., Ltd., of Nechells, Birmingham. Each of the drums is 6 ft. diameter in the roll and 9 ft. in the flanges, the width between the flanges being 3 ft., while the diameter of the drumshaft is 12 in. The drums are designed for taking 4,500 yards of rope of ⅞ in. diameter. Four brakes of the band type are provided, the bands being lined with "Ferodo" fibre lining. They operate on brake-rings bolted to the drum sides, and have renewable cast-iron cleading.

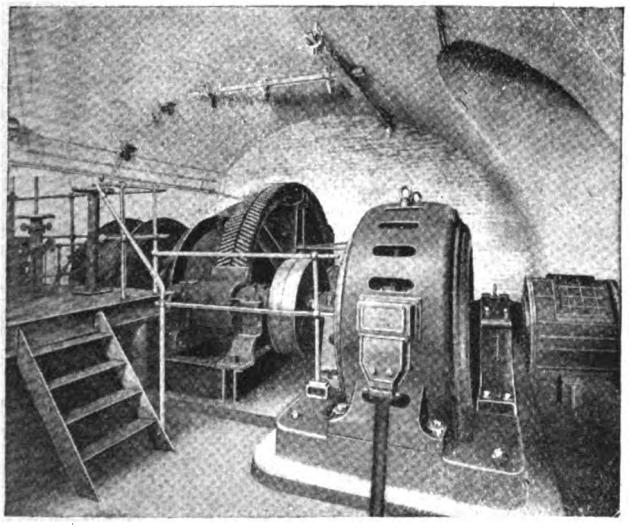


FIG. 3.—450 H.P. MOTOR DRIVING MAIN-AND-TAIL HAULAGE.

The driving power from the motor is transmitted through a felt and wood pad type of flexible coupling and reduction gearing by The Power Plant Co., Ltd., to the drum shaft. The speed reduction is approximately 10 to 1 and the gearing wheels have machine cut double helical staggered teeth. The motor speed is 400 r.p.m. Close to this 600 h.p. haulage is situated a twin endless haulage, the drums being on a common shaft. Each is rated a 110 h.p. and is driven by a 160 h.p. motor. The great advantage of this system is that in case of emergency the overload capacity of the motors enables either of them to drive both haulages for considerable periods.

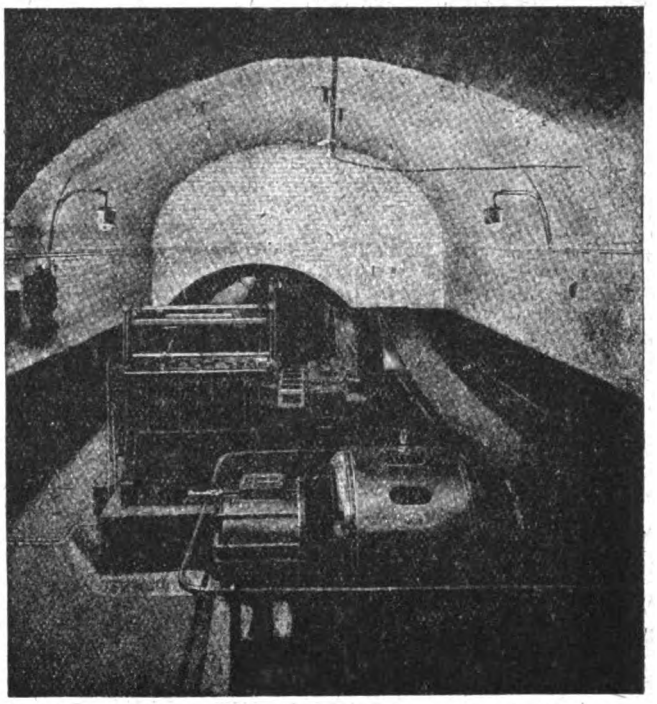


FIG. 4.—ENDLESS HAULAGE DRIVEN BY 85 H.P. MOTOR.

The hauling drums are 5 ft. in diameter at the bottom of the groove, which is 2 in. deep and 5 in. wide. The diameter of the drumshaft is 8 in. and that of the second motion shaft 5¼ in.

Power is transmitted through a "Hele-Shaw" coupling clutch in the second motion shaft. This clutch is capable of transmitting 110 h.p. at 130 r.p.m. Suitable arrangements of pinions on the motor shafts and second motor shaft provide a rope speed of 2.37 miles per hour when the motor is running at a speed of 580-780 r.p.m.

This endless haulage runs in the North and West districts of the South Pit, and is also fed by various auxiliary engines and the 600 h.p. main-and-tail haulage. In addition 600 tons of coal per day are dropped down an incline from the low main seam or North Pit, and thus conveyed to the South Pit shaft. In this way the endless haulage brings to the foot of the South Shaft the full 2,000 tons output of the South Pit and 600 tons from the North.

The gear and workings of the North Pit are on similar lines to those in the South Pit. The main difference is in the size of the haulages; the main-and-tail haulage being of 450 h.p. (Fig. 3), and the endless haulage of 85 h.p. (Fig. 4).

The mechanical equipment for both the endless haulage systems (in addition to the 600 h.p. gear already mentioned)

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was supplied by Messrs. M. B. Wild and Co., that for the 450 h.p. haulage by Coulson and Co., Ltd., Spennymoor.

A large number of motors have been installed for auxiliary purposes. These are nearly all of the slip-ring type, and range in output from an 85 h.p. unit for driving the Hutton Seam pump to small machines of 10-15 h.p., used for driving the machinery in the fitting and carpenters' shops, besides pumps, hoists, etc. The aggregate h.p. of motors supplied to this colliery by the General Electric Co., Ltd., totals about 3,000.

In conclusion, our thanks are due to Mr. J. H. B. Foster, General Manager and Chief Agent of the Easington Colliery Co., Ltd., and to the Company for permission to publish this description.

Note.—There are several ways of improving the power factor on A.C. systems, e.g., in some cases condensers may be used, and in others an over-excited synchronous motor running light is used, while a certain improvement can be obtained from converters. Most machines known as "phase-advancers" are rotary machines, but the moving parts of the "Kapp" phase-advancer oscillate, either horizontally or vertically. This machine is therefore sometimes referred to as the "Kapp" Vibrator. On a three-phase circuit there are usually three armatures, each vibrating in a two-pole field system (stator) which is excited by a weak direct current. Each armature (of the usual D.C. pattern, but about twice as long as its diameter and not under any external control) is connected in one phase of the rotor circuit, and as a result a torque is produced alternating with the slip frequency. This makes the armature vibrate, i.e., rotate alternately backwards and forwards, whereby an E.M.F. is induced leading the current by practically 90 degrees, and therefore the phase of the current relatively to the slip E.M.F. which produces it is advanced. The induced E.M.F. can be controlled by adjusting the excitation of the field magnet, and as it varies as line current ÷ the slip, an advantage is claimed at light loads and for slips of small magnitude.—An explanation of the theory and working of phase advancers is given by Professor Gisbe Kapp in Vol. II., Chapter XV., of his recent book, "The Principles of Electrical Engineering and their Application." 18s. 6d., post free.

SOME PROBLEMS IN MACHINE ROCK DRILLING AND MINE VENTILATION WHERE ELECTRICITY MAY BE BENEFICIALLY EMPLOYED.

The foregoing is the title of a Paper read recently by Mr. S. P. Blackmore before the S.A. Inst. of Elec. Engineers. He points out that the problem of drilling must be studied jointly with the following three points:—

1. The provision of a rapid and efficient drilling tool;
2. The suppression of the dust from drilling and the products of blasting;
3. The prevention of vitiation, and the provision of pure air for the sustenance of human life.

Not a difficult problem as the author shows.

Comparing air and electric drills he states that an electric drill would not suffer in reduction of drilling power or efficiency through wear, in the manner of an air drill. The work done in drilling will vary as the kinetic energy developed in the moving mass, and since the kinetic energy varies as the velocity, the rate of boring will vary approximately as the square of the pressure per square inch of the air power supply.

When air service pipes are installed, it is usual to allow pipe capacity on a consumption of about 15 cubic feet of compressed air per drill. If for any reason the demand should increase to the extent of an extra 50 per cent., which does occur sometimes, the pressure will fall as the velocity. If the estimated efficiency were 75 per cent. at a velocity of 25 feet per second, the transmission efficiency for that section will fall thus:—$37.5^2 : 25^2 :: 75\% : 33.4\%$.

An electric drill would not be so sensitive to change of condition. No such demand for power would be possible without utter failure of the motor. If a spring breaks it requires immediate replacement. A worn piston rod would not cause any loss of power, neither would any of the moving parts, which would have a very much longer wearing life, as they need not be air-tight.

Hitherto electric drills have been designed on too fragile lines, the small cams, rollers, crank-shafts, pawls, springs, are undesirable, expensive to a degree and calculated to cause trouble. If a change is to be made, it must be something simpler, more reliable and economical in up-keep.

The squirrel cage poly-phase motor is capable of the most robust construction for its application as the motive power. The flexible shaft is a robust device, and properly constructed gear wheels need not be fragile. Oiling offers no difficulty.

Describing a polyphase drill the author points out that it is of concentric construction, the rotor, which has a hollow shaft, being carried on the drill bar or piston, around which it is free to rotate. Attached to the rotor is one of a pair of helical cams, the other being fixed to the rear of the drill bar, which is bossed to receive it. The drill bar or piston is prevented from rotating with the rotor by means of a rifle bar and nut, being secured in a hollow which is bored in the rear end of the bossed portion of the drill bar. The rifle bar, with the usual ratchet wheel pawls, etc., is accommodated in the rear end of the casing, which encloses the cams and rear end of rifle bar, and rotates the drill in a direction opposing that of the rotor and cam.

The spring is secreted in the casing at the rear of the drill bar and surrounding the rifle bar, the other end of the spring being supported against the rear end of the casing.

As the rotor revolves, the cam which is affixed thereto forces the other, which is affixed to the drill bar, backwards thereby compressing the spring. As soon as the cams have passed their limit of expansion the spring will drive them together again with percussive force.

When tested on a supply with frequency rapidly varying between 40 and 70 cycles it was found that the drilling speed in hard Aberdeen granite was 0.72 in. per min. at 51 cycles, 1.32 in. per min. at 51 cycles and 2.73 in. per min. at 70 cycles—the machine then striking some 630 blows per min. The author is of opinion that 1,000 blows per min. would give the best results.

Up to the present, the various electric drills have only struck from 300 to 600 blows per minute, and were of the short stroke type, excepting those of the solenoid type, which he regards as wrong, electrically, and does not think they will make much headway industrially. It was seen at an early period of the experiments that the short quick stroke of the motor-driven drill was an essential to speedy work, for the principle would not permit of blows of high energy value, unless very heavy springs were employed, moreover, it was seen that the light and numerous blows made better headway for stoping purposes, and that smaller drills were desirable and encouraged greater drilling speeds, with less wear of the drilling machines.

The question as to whether light hammer type drills or the heavier piston type should be used will depend upon factors other than merits of the drills themselves as drilling agents, where stoping operations in particular are concerned.

It is up to electrical engineers to give the question of the electric drill more consideration, and to evolve a machine from the results of past experiments which will successfully replace the compressed air drill of to-day, in both first cost and upkeep.

The telephone number of **G.E.C. Publicity Organisation** (92-4, Queen Victoria Street, E.C.4) is now Central 2604 and 2605.

An illustrated descriptive leaflet dealing with the 4,500 k.v.a. Fraser and Chalmer-G.E.C. turbo-alternator set recently erected for the Newport Corpn. in their East station is being circulated by the **General Electric Co., Ltd.**, of Magnet House, Kingsway, W.C.2. The turbine (Rateau impulse type) is now working on a steam pressure of 165 lb. and 150 deg. F. superheat, but it has been designed for easy conversion to a working pressure of 250 lb. when a new steam-raising plant has been installed. An alternator to give 6,250 k.v.a. at the same speed (3,000 r.p.m.) is on order.

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UNDERGROUND HAULAGE BELLS AND TELEPHONES: TROUBLES AND THEIR REMEDIES.*

BY J. S. KENDAL.

(*Continued from page* 326.)

With regard to the installation of the bells and keys, it is good policy in main roads to provide a brick-built chamber roofed with good timber girders or sheets to give protection. The apparatus may either be mounted direct upon the wall or upon a board affixed to the wall. Where the apparatus is provided with a separate gland or terminal for each connection, V.I.R. wiring may be used on porcelain cleats as in Fig. 2. Where a single gland is provided for leading in a more satisfactory job is obtained by the use of multi-core cab-tyre or similar cable running to a small terminal base as shown in Fig. 3. This second method gives a neat arrangement and allows faulty apparatus or wiring to be removed and replaced with a minimum of disturbance to the system. Incidentally, such renewals of wiring will be of less frequent occurrence than with many other systems. Where single-stroke bells of the block-signal type are used in conjunction with batteries, a good arrangement is to have a cupboard about three feet high containing the batteries and having a wide flat top to serve as a support for the bells.

From observation made, batteries of the common Leclanche type appear to suffer mostly from the housing problem chiefly because of what may be termed the sanitary conditions and overcrowding. One occasionally comes across batteries which appear to be entirely ignored, being tucked away in any old corner, under seats, on top of walls, or placed in open-topped boxes which become filled with all manner of rubbish. It is really wonderful how such apparatus performs its work. Leclanche cells, if properly fixed and cared for, will give really good results. Of late years many collieries have installed small motor generators and accumulators to provide the current required for working their haulage signals, and where the work is confined to a small area with heavy traffic this arrangement can be recommended. In some cases where the districts are fairly scattered, it would be an expensive matter to have a number of such generators; even if only one were provided, say, at the shaft haulage, much inconvenience would be caused if the supply wire broke near the out-bye end, thereby putting out of use all the branch roads or auxiliary haulages beyond this point. In such cases it is the usual practice to keep each haulage system entirely separate, providing each one with its own battery.

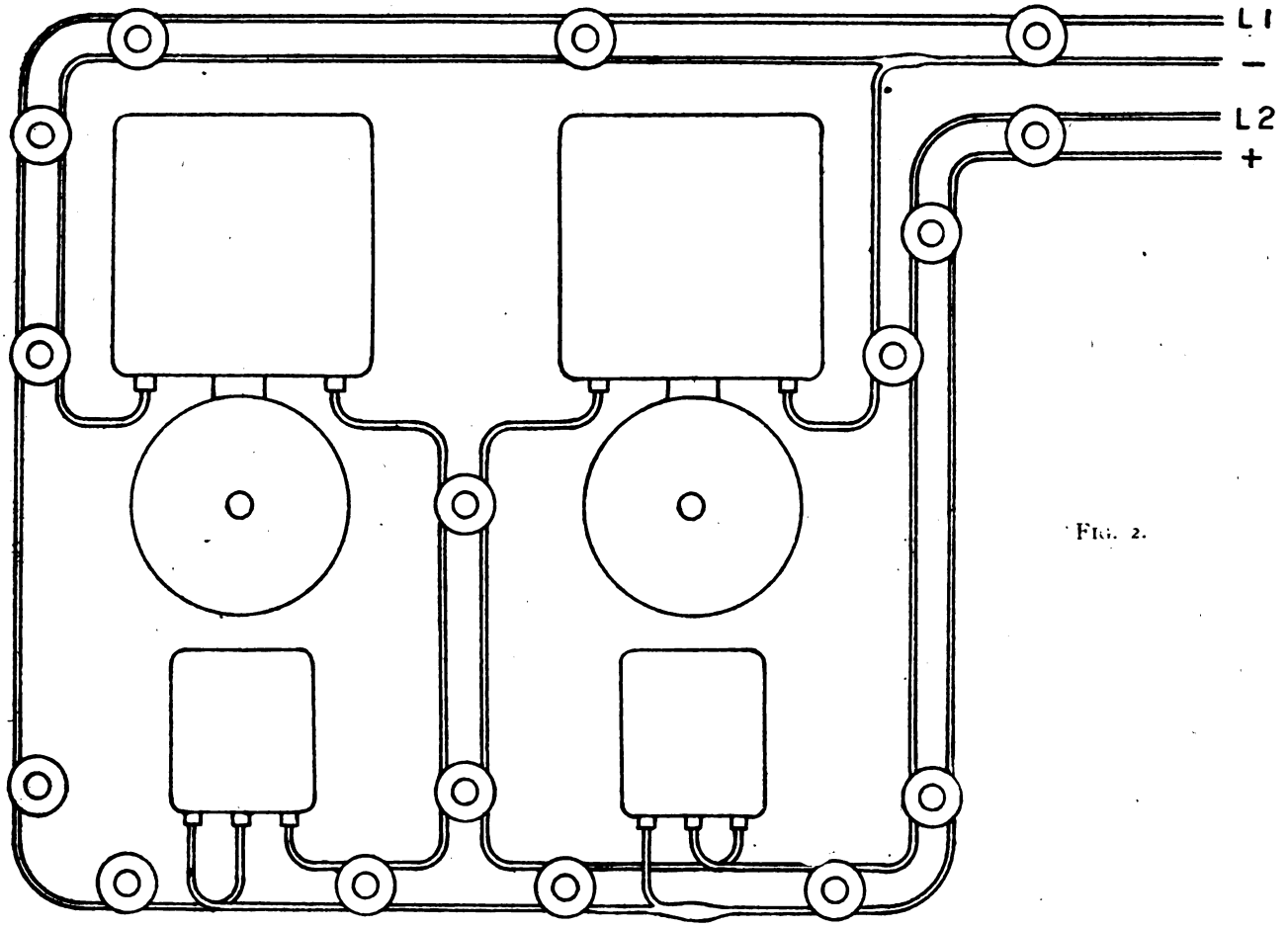


FIG. 2.

The type of battery almost exclusively used for underground signalling is the Leclanche, and these should be fixed on shelves or cupboards in a cool dry place. Where a number of bells are required to operate in parallel it is desirable also to have the batteries in parallel, otherwise the battery will be overworked and have a very short life. The jars should be little more than half-filled, using clean water, which, if not immediately to hand, may be carried in a kettle or other container having a spout by means of which the jars may be conveniently filled. The solution should not be too strong as a saturated solution tends to crystallise the zincs and leads to creeping. A cell which shows signs of creeping should be immediately taken out of use and re-varnished; if allowed to continue it would probably empty itself and cause a stoppage. Porous pots should be filled with powdered manganese oxide in preference to the granulated variety and the carbons should be fitted with Britannia metal terminals, brass terminals being liable

*Paper read December 18, 1920, before the North of England Branch of the Association of Mining Electrical Engineers.

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to corrosion by the fumes from the cell. If brass terminals are used they should be smeared with vaseline to prevent corrosion. If only a small current is needed, the gassing effect of the cell can be avoided by the use of a solution of chloride of manganese in place of the usual sal-ammoniac solution. The author has never seen this solution used for colliery work but it is largely used by the Post Office for telephone ringing purposes. Its adoption, however, necessitates the use of closed battery boxes in order to prevent contact with the atmosphere.

Hard porous pots should not be used as they offer too great a resistance, and some pots are far from being fully porus, as apparently they would hold liquid for an indefinite period; their action may be improved by drilling a few small holes through them. Zincs are another item which give a good deal of trouble. Where heavy currents are used railway pattern zincs may be used to advantage.

A trial of this method gave the following results and some of these reclaimed pots have now been in use for more than ten months.

Voltage before Treatment.	Voltage after Treatment.
0.8	1.2
1.0	1.2
0.95	1.1
1.0	1.25
0.7	0.95
0.8	1.05
0.75	1.05
0.2	1.05 (new manganese).

CHOICE OF APPARATUS.

A good deal of the trouble experienced in the operation of signalling gear may be attributed to unsuitable apparatus. Although great advances have recently been made in the design of bells and telephones for mining use there are still many minor details which call for attention, more particularly in the mechanical design. While discussing these points it would be well to draw the attention of manufacturers to the following defects frequently found on otherwise modern gear.

(To be continued.)

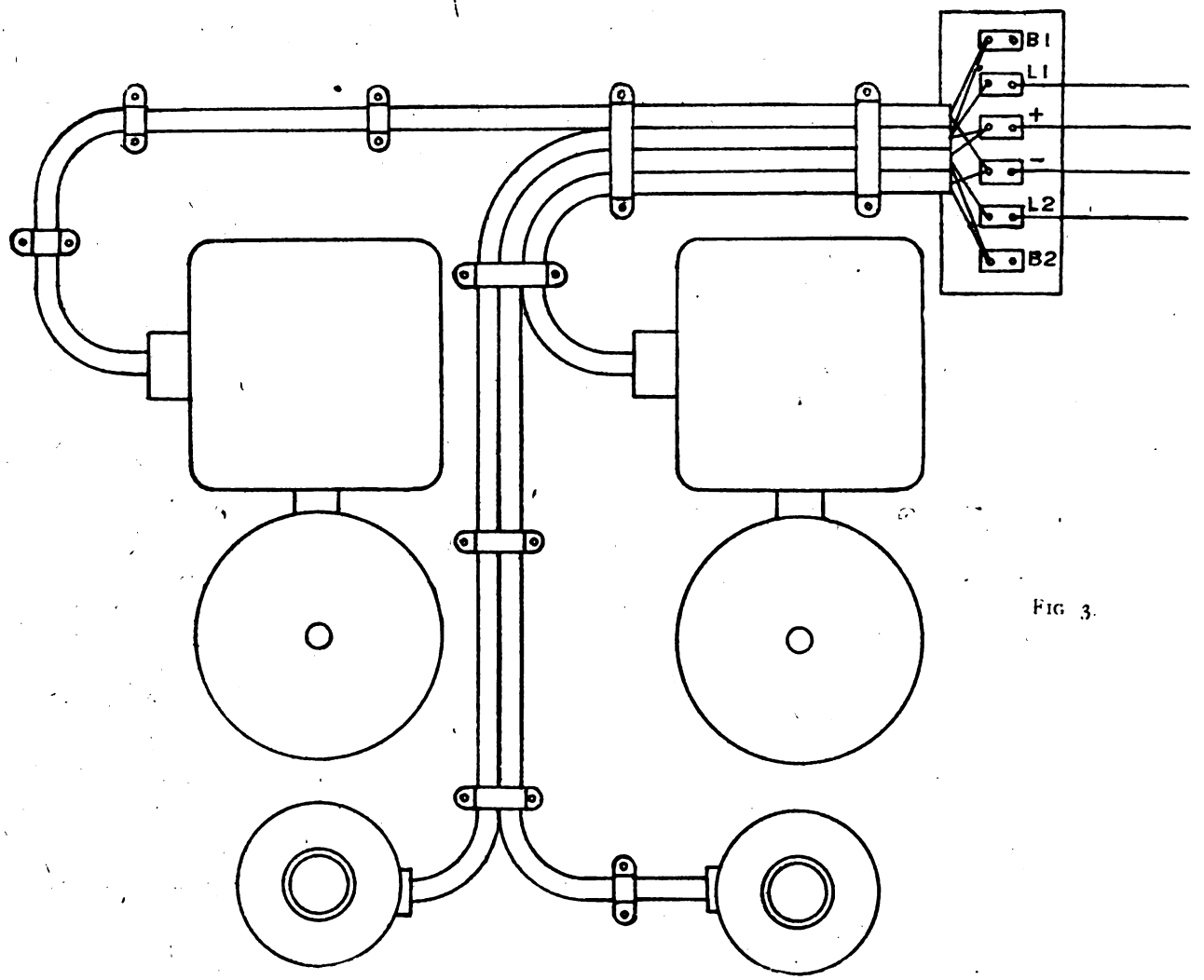


FIG 3.

All batteries should be provided with a conveniently placed switch to enable them to be cut out of use at night time and week-ends when not required. With regard to the maintenance of batteries, they should be overhauled and cleaned at regular stated intervals; by so doing a good deal of trouble may be avoided. Any cell which gives a reading below one volt should receive particular attention and weak or run-down porous pots may be revived by a method advocated by Mr. W. J. Thorrowgood in a paper read before the Institution of Railway Signal Engineers.

This treatment consists of soaking for 24 hours in a solution of one part of hydrochloric acid to five parts water.

Personal.—Mr. Harold E. Webb, A.M.I.E.E., has been appointed London Office Manager by Bruce Peebles and Co., Ltd. Mr. Webb has had a long connection with the company and is well known to their many customers in the London area.

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PAGES FROM OUR DESIGNER'S NOTEBOOK

WESTON ELECTRICAL INSTRUMENT CO LTD

AUDREY HOUSE · ELY PLACE · LONDON · E.C.1

THE WESTON INSTRUMENT ON FLUCTUATING LOADS.

A TEST THAT DEMONSTRATES THE VALUE OF CORRECT DESIGN.

On commercial circuits the load is continually and often abruptly changing in value, and an instrument that cannot follow the changes without a serious sacrifice in accuracy and facility of reading will be of little assistance in the efficient operation of a plant.

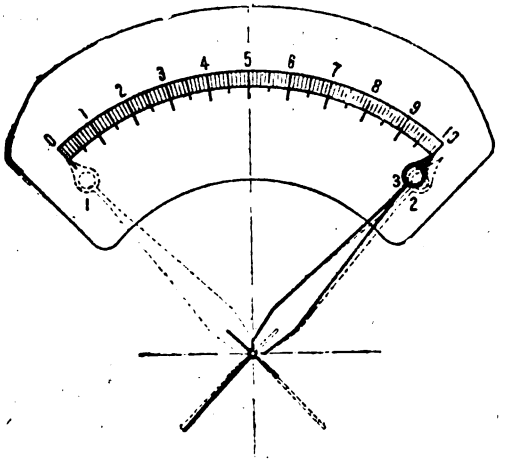
To indicate the true conditions under fluctuating load an instrument must have a high ratio of working torque to weight of the movable system, and it must be effectively damped.

High torque instruments should be regarded with suspicion as high torque alone signifies great weight and therewith large friction torque and inferior durability. The correct method—which is employed in all WESTON instruments—is to provide a high ratio of torque to weight, and this is effected by reducing the weight of the movable system to the lowest limit and by properly distributing its mass.

In result, WESTON instruments may be read with accuracy even on widely fluctuating loads, and the degree to which this is possible is brought out very strikingly by the following test.

Starting from no load a sudden application of full load produced a total overswing of only two divisions as shown in the diagram, the numbers on which indicate the successive positions of the pointer.

In this test, which is the most severe that can be applied to an instrument, it took the pointer just two seconds to come to perfect rest. The instrument could easily be made absolutely dead beat, but a slight overswing is desirable to show that the movable system is free from friction.



DAMPING TEST ON MODEL 167 WATTMETER.

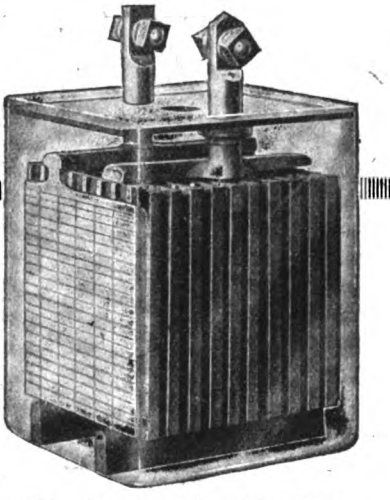
A similar test on an ordinary instrument would have caused a violent collision with the stop and almost certain damage, but owing to the efficient air damper, the perfect balance, and the lightness and low moment of inertia of the WESTON movable system all possibility of damage is eliminated.

For full particulars write for catalogues. G

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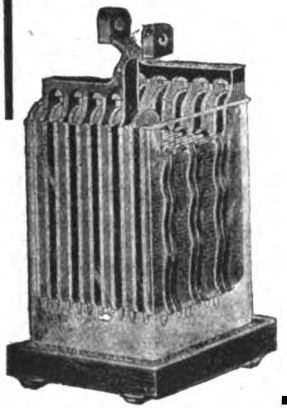
THE Chloride ELECTRICAL STORAGE COMPANY LIMITED.

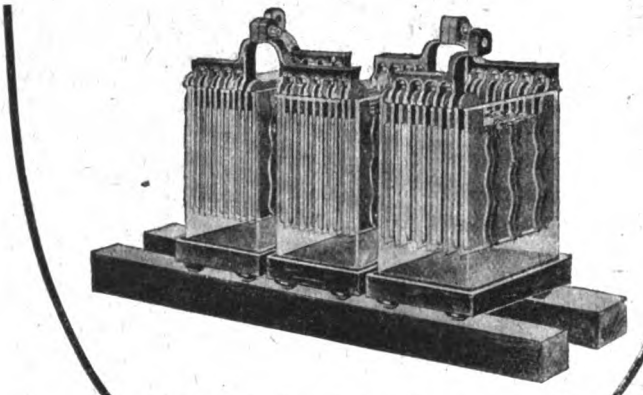
Clifton Junction, Near Manchester. **57, Victoria Street, London, S.W.1.**

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The set illustrated is the "Bridge-Megger" for testing insulation at or above working pressure, and measuring low resistances.

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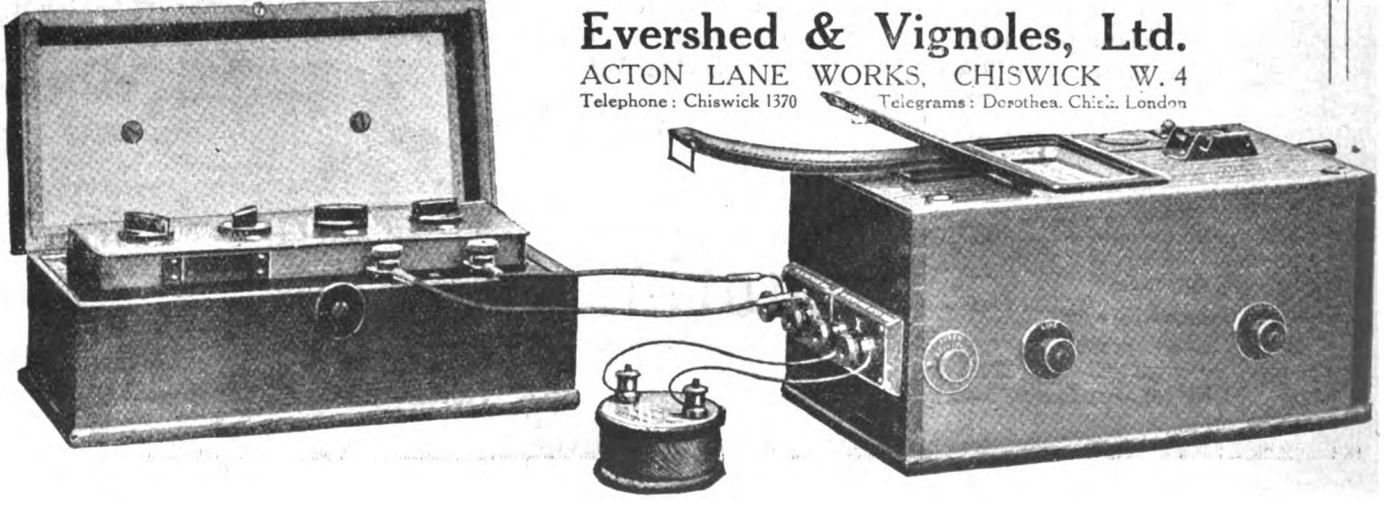
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 1d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application.

Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Tramway Losses.

The Walthamstow Urban District Council has been losing £3,000 a month on its tramway undertaking for a number of months past. Last year's deficit was no less than £26,000. The Council have decided to raise the fares and create a minimum of 1½d. The experience of Walthamstow, as is the case with a large number of the smaller towns owning tramway undertakings, has been highly disappointing, and it should not be overlooked that all those undertakings which fail to pay their way must inevitably become a more or less perpetual burden on the local rates. It is an entirely false principle to argue that a public utility like a tramway service is an absolute necessity and as such must be maintained, irrespective of whether it is capable of earning its own expenses.

It is the silent and general acceptance of this principle by so many undertakings of this character which is adding to the Englishman's burden every day. Similar principles should apply in municipal trading as are applicable to private enterprise, and the undertaking, be it tramways, electricity supply, gasworks, or any other communal business which is not self-supporting, should be subject to stern and drastic survey on business principles. If the present state of affairs continues we shall ultimately reach a stage at which all these costly undertakings will be subsidised by the unfortunate contributor of rates and taxes who derives no enjoyment from the questionable privilege of fighting for a place twice or four times a day and then hanging on to a strap for weary miles.

Generally speaking there is much room for private enterprise in connection with public passenger transport to-day. In a good many populous centres the municipal undertakings can neither carry the public in reasonable comfort, nor can they pay their way even under the unhealthy and dangerous overcrowding which prevails. Nevertheless, most of the authorities concerned look askance at any proposal by a private business enterprise to run motor-coaches or 'buses as relief services. It is a dog-in-the-manger policy which should not prevail; if private enterprise can carry the public in comfort and at reasonable cost over routes where the municipal service is inadequate the local councils should not have the power to refuse any bonâ-fide application for powers to compete. In this connection I am glad to see that Liverpool has adopted the common-sense policy of permitting motor-coaches to assist with its overwhelming tramway traffic during the coal strike. There is ample scope for motor-coach services in this city even when fuel supplies are normal, and I shall hope to see them retained when the mines are again at work.

"Cheap" Electricity.

We shall never see a real revival of the electrical industry in this country until electrical energy is once more cheap and plentiful. It is no good preaching the gospel of universal electrification with consequent cleanliness and labour-saving if at the same time the supply of essential "juice" is both inadequate and high priced. The post-war super-power stations have fizzled out as an unrealised dream, and it looks as if we of the older generation shall never live to see that electrical Utopia which has been foreshadowed by the cheery optimists of two years or so back. When one takes a mental bird's-eye view of the parochial character of most electricity undertakings and realises how hopelessly involved they must be financially, to say nothing of the inefficient methods of generation which prevail in so many cases, one realises the difficulties of the problem with which this country is confronted in the matter of securing a "cheap" supply of electricity.

But for the present financial stringency and the pressing call for economy, coupled with the obvious necessity to carry on somehow, it would really pay, in the long run, to scrap a good many existing supply undertakings rather than continue to run them at so heavy a loss as they must inevitably be incurring. That, of course, is the ultimate policy in those cases where a bulk supply is in process of arrangement, but meanwhile the losses are building up into irreconcilable totals and it is the penalty we pay for local municipal government that no burdens piled up in this manner by local inefficiency and mismanagement can be wiped off the slate to give any new and efficient system a fair start. Municipal trading cannot cut its losses and start afresh; it is always adding to the local debt and increasing the difficulties for those who come along later.

Mis-Firing.

The growth of motor traffic on our roads since the war has been enormous, and during the fine weather we have been experiencing this spring it is quite an interesting sight along some of the more popular roads to watch and remark upon the behaviour of some of the many types of vehicle one sees. As a motorist of many years standing I have remarked among other things that the percentage of internal combusion-engined cars and cycles on the road, which are not firing regularly,

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is unduly high. The split-splutter and bang of a misfiring engine is quite a common feature, and one notes an accompanying look of worry and perplexity on the face of the average driver. I do not know whether the trouble is in the main attributable to British magnetos or whether the average modern motorist and driver is not sufficiently *au fait* with the important function performed by his magneto and plugs.

The modern magneto, whether British or foreign, and the modern sparking-plug are both highly efficient and reliable if they receive that small periodic attention which is necessitated by the arduous conditions under which they operate. There are plugs to be obtained to-day which will maintain an efficient spark in the oiliest of engines, whilst the general mechanism of the average magneto will wear indefinitely. It is in the contact-breaker of the average magneto that the true secret of satisfactory engine performance is to be found. The opposing platina *must* be kept clean and level, making contact over their entire surfaces. Few drivers possess the knack of trimming their platinum contacts successfully and without waste of this precious metal.

Nor are the motor text-books infallible guides in this connection as most of them advise "filing" (*sic*) the platinum surfaces, and talk glibly of "visiting cards" as gauges for the correct separation of the contact surfaces at break. There is an art in keeping magneto contacts in condition which is born only of experience. You cannot successfully re-surface badly worn points by removing them from the contact-breaker and dealing with them individually in a lathe, for the simple reason that no matter how carefully the job is done, even using the finest of emery paper, the outer circumference, travelling at a higher speed, will naturally give up more of its metal than the exact centre, the result being a convex surface, which may or may not be evident to the naked eye. The simplest and easiest way to re-surface these contacts is by judicious application of a slip of very fine emery cloth wrapped round a thin strip of metal and passed backwards and forwards between the two platinum faces when in position, compensating for the minute layer of metal removed by a very slight adjustment of one or other of the contact screws. Even this method does not take into account the angularity due to the radius of the rocker arm about its fulcrum, but it is quite good enough for all practical purposes and I have adopted it successfully for years.

Scientific Societies.

As is well known, many of the smaller scientific societies have had considerable difficulties in maintaining their work throughout the war period; indeed, the persistance with which such bodies "carried on" is highly creditable. Their troubles, however, are by no means over, one of the most serious being the great advance in the cost of printing and dispatching their publications. I observe that the Conjoint Board of Scientific Societies has been taking up their case and proposes to present to the Government a suggestion that a grant in aid of publications by various constituent societies should be furnished. The amount required is doubtless a moderate sum, and I think that, even in these days of enforced economy, the suggestion should receive sympathetic consideration.

If ever judicious expenditure were warranted it is in connection with education and research, in which this country in the past has been admittedly deficient. The Government has acquiesced in greatly increased expenditure on national education. It ought not, therefore, to turn a deaf ear to a plea on behalf of the dissemination of scientific knowledge—a function voluntarily undertaken by the scientific bodies in this country at their own expense and surely deserving of some encouragement.

Labour and the "Square."

I note with interest that one of the leading subjects to be tackled at the Labour Conference to be held at Brighton next week is "Should Labour Leaders be Freemasons?" The Lewisham delegates will raise the question in the form of a pledge to be demanded of all Parliamentary Labour candidates "that they are not Freemasons." I suppose the great principles of brotherly love, relief and truth on which the order is founded do not appeal to the Lewisham gentlemen, and they would prefer quarrels, deceit and the real red "dictatorship of the proletariat," which is only another name for the vilest tyranny by which crafty men with the biggest lung power raise themselves above their fellow workers and then fleece and coerce them to their heart's content.

I expect the real trouble is that some prominent Labour leaders in the House are on the "square" and do not therefore see eye to eye with the views of the extreme Communists, but just do their best for their Labour constituents in an honest, straightforward manner. That is exactly what you would expect of a true Mason, and I hope the proposal will meet with the reception it deserves. Genuine Labour leaders or trade unionists are as welcome in the great brotherhood as any class of the community so long as they conform with the essential requirements in the way of religious belief, loyalty and integrity. If more of them join it will, in my opinion, be all the better for the harmonious working of the country's institutions and the friendly feeling between man and man.

ELEKTRON.

THE ENGINEERS' CLUB.

At the general meeting held on the 2nd inst. the Engineers' Club was brought into being with every prospect of being housed by July 1 in suitable premises, one minute from Piccadilly, three minutes from Leicester Square and five minutes from Trafalgar Square and Strand tube stations. The constitution will be a company limited by guarantee under the Companies Acts to £5 per member as a maximum, and the acting executive committee has been continued in office till the first annual general meeting. It was stated that provisional forms of application had been received signed from 902 town, 563 country and 200 from overseas and foreign members. These numbers were being added to daily, and there was every indication that 3,000 members would be obtained by July 1, and 5,000 by the end of the year.

After discussion it was agreed that the club be primarily a social club, with opportunities for discussing business when desired.

Late enemy aliens are not to be admitted, but foreign members will be admitted, though the precise terms are not yet finally decided.

Mr. E Manville is the first President and Mr. Edmund L. Hill, who has been acting temporarily, is now officially appointed Hon. Sec for the time being at 39, St. James's Street, S.W.1 (telephone: Regent 6050).

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G.E.C. ELECTRIC FANS

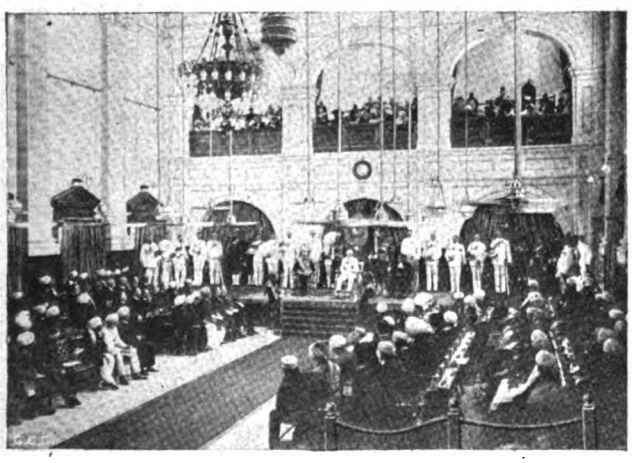
The accompanying illustration shows the inaugural ceremony of the new Council Chamber at Madras by H.R.H. the Duke of Connaught. We reproduce it chiefly because in it may be seen some of a large number of "Witton" (Swan's Patent) electric fans. It will no doubt be remembered that these fans are of a special design for use in tropical climates. They have three curved blades of 54 in. sweep, automatic lubrication, which reduces friction to a minimum and a liberal mechanical design. The motors are fitted with ball thrust bearings running in an oil bath.

While on the subject of fans reference may be made to the receipt from the G.E.C. of a pocket-sized booklet dealing with their well-known "Freezor" electric ventilating fans, which are available for immediate delivery to meet the anticipated heavy demand during the summer months. The new "Freezor" fan works at Witton are claimed to be the largest in the country devoted exclusively to the production of electric fans, are laid out on the most up-to-date lines and equipped with the most modern machines, many of which are automatic. Standardisation of parts, all of which are made to gauge, good organisation and rigid inspection at all stages have resulted in large outputs at moderate cost.

Although many types are listed in the booklet referred to, the Company are drawing particular attention to the following:—

The laminated pattern D.C. "Freezor" fans (Patent No. 9706/09), which are fitted with swivel and trunnion movements and can be arranged for either desk or bracket use, it being possible to set the fans to blow in any desired direction without additional attachments. These fans are 12 in. in diameter, weigh 13½ lb., and consume 36 watts.

The "Koolah" Ceiling fan, primarily designed for use in tropical climates, is, however, quite suitable for use in Great Britain. Three blades having a total sweep of 54 in. are driven by a motor fitted with self-oiling thrust bearings and consuming 115 watts. The mechanical and electrical details are very carefully proportioned so that



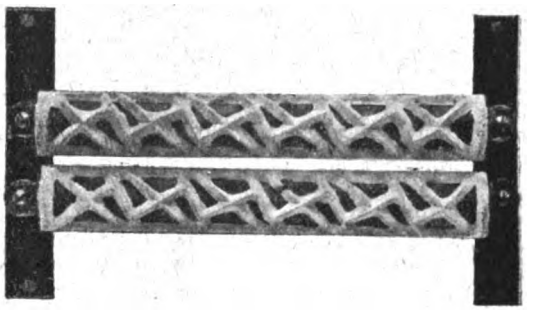
the fans are practically noiseless. The blades are held in place by a screw which passes right through the stem so that all risk of their falling is avoided.

Exhaust fans with box blades are made in a range of sizes from 12 in. in diameter, giving an approximate displacement of 750 cub. ft. per min. for a consumption of 50 watts, to 60 in. diameter, displacing 21,000 cub. ft. per min. and consuming 1,000 watts. These fans are extensively used for ventilating large apartments, steamships, restaurants, smoking rooms, etc., and have recently been adopted for the ventliation of rooms in which X-ray apparatus is used, as it has been proved that many of the diseases to which X-ray operators are so liable are attributable to the ionisation of the air surrounding the apparatus. If this air is frequently changed the risk of these diseases is greatly reduced

DOMESTIC HEATING.

A Furnace Type Fire Bar.

A new design of patented fire-bar element of the standard 500-watt capacity has been designed by the Automatic and Electric Furnaces, Ltd., 281-3, Gray's Inn Road, W.C.1. The construction (see illustration) was adopted as a result of experience obtained in the construction of electric furnaces. The element is about one inch in diameter and is hollow, with an open front provided with irregular criss-cross pieces. The heat is produced by the passage of



current through a very closely-wound helix of special wire placed inside the refractory tube, the heat produced being sufficient to cause the whole mass to glow. The criss-cross pieces already referred to effectively break up the monotony and severity which would otherwise result and give a most pleasing effect, and at the same time a long life is assured by the manufacturers, whose successful experience in the production of electric furnaces enables them to embark in the domestic heating field with a full understanding of the problems met with in the design of reliable high-temperature heating elements.

WAGES REDUCTIONS.

The National Federated Electrical Association, 11, Southampton Row, W.C.1, sent a letter signed by Leonard G. Tate, General Secretary, on June 1, to all members of the three Associations, etc., interested in the wages question in the electrical industry, as follows:—

"In accordance with the National Wages Agreement between the Electrical Trades Union and the National Federated Electrical Association, dated August 7, 1920, the respective parties hereby agree:—

"To vary the wages of all Grades in accordance with the recommendation of the National Conference at York, April 20, 1921, reading as follows:—

'It was agreed to mutually recommend a reduction of 10 per cent. in the present rate of wages in two instalments—namely, 5 per cent. to come into force on the first pay day following May 9 for the pay period covered by that pay day, and a further 5 per cent. to come into effect on the first pay day following July 9 for the pay period covered by that pay day.'

"Note.—This recommendation is without prejudice to the revision of wages due in July provided by the National Standardised Wages Agreement.

"It is agreed that there shall be no victimisation by either side. Complaints under this head to be investigated by Joint Committee or existing machinery, and no stoppage of work to take place pending such investigation."

Signed on behalf of the N.F.E.A. by P. Collinson and L. G. Tate, and on behalf of the E.T.U. by J. Rowan, J. Kinniburgh, H. P. Bolton and J. Illingworth.

Fiji.—The Municipality of Suva is calling for tenders by the end of the month for a 200 kw. 500 D.C. Diesel oil engine set, together with switchboard.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 119.

There were some fuse boards recently delivered to our works. The fuse clips are fixed to iron rods insulated with what appears to be mica or micanite. I would like to know how mica is placed round the iron rods in this manner, and what material I shall require to insulate the rods if a breakdown should occur.—"CLIP."

QUESTION NO. 120.

The distance between my house and a store is two miles. I wish to rig up a signalling apparatus between them so that I can be called up at the store if I am required at the house. I do not wish to go to the expense of fitting electric bells on account of the cost of wire and the inconvenience of running them. Can I use a system of wireless? If so, please can you give me some details that will assist me?—"COHERER."

(Replies to Questions Nos. 119 and 120 must be received not later than June 25, 1921.)

Answers to Questions.

QUESTION NO. 117.

The construction of stone cellular type switchboards is not generally understood. Please can you give me some idea of the contents of a cell for, say, a generator panel? What safety and protective devices are necessary to make the cell foolproof?—"TRANSFORMER."

REPLIES TO QUESTION NO. 117.

The first prize (10s.) has been awarded to Mr. D. J. Wilson, 185, Barnsley Road, Cudworth, near Barnsley, Yorks, for the following reply:—

It is proposed to describe the generator panel of a cellular type switchboard (mounted upon a balcony) suitable for use with a three-phase generator. The cells would in this case be four in number, the upper chambers for the busbars; then would come the chamber for the isolating switch; next, the main switch chamber; while the bottom chamber would be used for the instrument transformers.

The cell work is placed behind the panels, as shown in the sketch, leaving ample clearance between the back of the panels and the front of the cell work. It is usual to leave the aisle thus formed quite open at either end; since the front of the cells are protected by a series of expanded metal doors. By this means the attendant can, without danger, during his tour of inspection, observe and report such defects as overheating, etc.

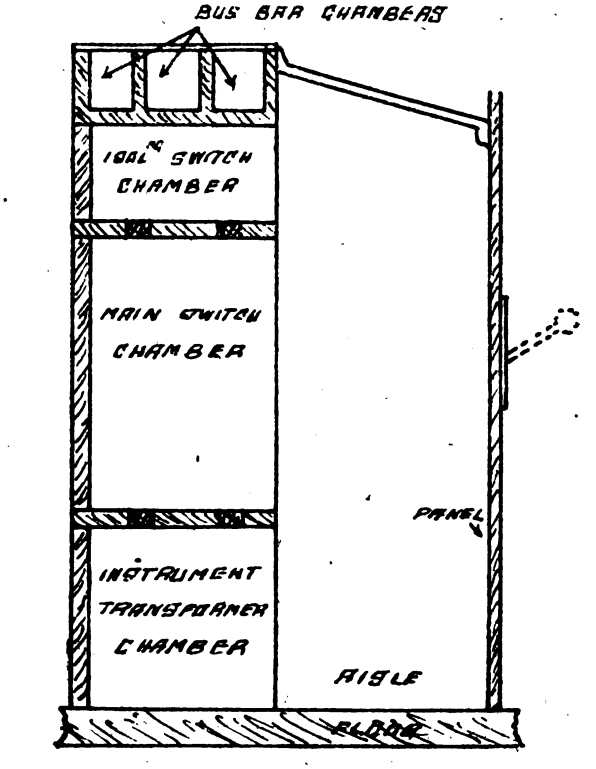
The switches are controlled by a system of levers and bell cranks, which pass from the switch handle, down behind the panel, under the floor, and up to the switch. The bell cranks, two in number, are mounted in brackets, bolted to the floor, and the levers are adjustable in length by means of screwed fittings. In some types the control is by means of chains and levers, while in others, wire ropes and pulleys with levers; each system passing under the floor. In the case of a generator switch three clearance slots would be made in the bottom of all four chambers to pass the incoming or outgoing feeders. Insulators and stirrups would be bolted to the sides of the cell work to support the feeders.

The cells for main switches of, say, 1,000 amp. capacity and over are usually fitted with expanded metal doors at the back of the chambers, thereby providing better ventilation and greatly facilitating repairs.

Commencing with the isolating switch chamber, this would contain one triple-pole isolating switch fitted with detachable handle. The switch can then be operated by authorised persons without opening the chamber door.

The switch chamber would contain one oil break, triple-pole circuit breaker fitted with overload and no-volt release trips, and insulators to support the feeders.

The transformer chamber would contain, in addition to the feeder supports, three current and one potential transformer for use in connection with the switchboard instruments; the release coils, and probably the regulator.



An earth bar is run behind the two lower cells, being connected to all adjacent ironwork, the current transformers and, possibly, the neutral point of the L.T. side of the potential transformer.

Occasionally one cell suffices for both switch and transformers, and, in this case, only one earth bar is run, though it is desirable in all cases to use a separate chamber for the isolating switch.

The front edges of the chamber are faced with 2 in. by $\frac{3}{8}$ in. wrought-iron bars, which are fixed to the stonework by means of countersunk set-screws engaging nuts made of round stock, drilled diametrically, and fixed transversely in the stone. These facings are tapped to receive the four hexagon-headed set-screws which fix each door, each cell being fitted with a separate door. The doors are each fitted with two handles and a number of metal strips projecting about two inches over all the four sides, so that it is impossible to let the door fall into the cell when taking it down. Hinges are not fitted, each door rests upon a projection and is secured by the set-studs previously mentioned.

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There is no communication with the cells belonging to the next panel beyond the small slot for the earth bar, so that, if isolating links or switches are fitted, repairs can be carried out in safety while the rest of the plant is in operation.

Since the doors cannot be taken down without the use of a spanner, and only authorised persons are allowed behind the panels, the cells are effectively protected. A mechanical locking device is sometimes fitted, which renders it impossible (even though the studs be taken out) to remove the doors until the isolating switch or switches are opened. This renders the cell foolproof. The panel is, of course, fitted with the usual devices to attain this end, and also with the necessary instruments, synchronising plugs, etc.

It should be noted that as the cells are sectional and each complete in itself, they can be "added to" indefinitely. Further, they can be transported with ease, as they are built up *in situ* from slabs fixed together by steel dowels, or stone dovetails, and cemented with a special quick-drying cement. Ledges, grooves, etc., are also provided to facilitate erection and to add to the stability after completion.

It is, of course, understood that this "stone" is moulded by the makers, as are concrete window sills, paving stones, etc.—D. J. WILSON.

The second prize (5s.) has been awarded to "B.L.Y.," for the following reply:—

The cellular type of switch-board is generally used for A.C. high-tension control, and may be classified as either direct or remote control. This type is also used sometimes for D.C. control, and, when so used, the main supports will consist of heavy slate slabs cemented into the engine-room wall, and divided into a number of cells by means of vertical removable division plates sliding in grooves on the horizontal slabs. The connections between various fittings are made by gun-metal or copper castings cemented into insulators, these being fitted into the slate slabs. This arrangement thus dispenses with the back as used on other types, also all connections can be traced from the front with no possibility of same becoming loose. For a D.C. dynamo, the number of cells would vary, depending upon the instruments, etc., considered necessary, but would at least consist of two single-pole circuit-breakers, each fitted with O.L. and N.V. releases, and if intended to work in parallel with other machines, with a reverse current trip; also two single-pole linked knife switches, interlocked with circuit-breakers, so that C breaker is closed first, thus leaving it free to act, in case of wrong switching, etc., when knife-switch is closed. Other accessories would include an ammeter and voltmeter, earth leakage indicator, wattmeter, shunt regulator with discharge resistance, also power fuses, and a paralleling switch, if generator works in parallel with others. For high-tension switch-gear the cubicle arrangement is adopted both for safety and also to reduce the space which would be required for the ordinary lay-out. These cubicles are usually arranged under the floor of control board, and each would contain, say, (1) Series transformer for alternator ammeter, (2) main oil-break circuit-breaker, (3) isolating switches, (4) potential transformer for voltmeter. The secondary leads of transformers would be carried by cables in conduit to control board, whilst bus-bars would be provided in separate cells to suit number of phases and circuits. If direct control is used, the various gear will be operated by link motion from board above, or if by remote control by means of buttons, using direct current for the solenoid control; the connections being shown on the control board; this being the switchboard on a miniature scale. The safety devices such as lighting arresters and synchronising gear will be in other cells together with such recording instruments, as necessary. Each cell would be fitted with expanded metal or sheet-iron doors, these being interlocked with switchgear to prevent access, except when dead, and also to prevent operation until doors are closed.—"B.L.Y."

ELECTRICITY ON THE FARM.

The repeal of the Agriculture Act (1920), Part I., will bring about reduced wages for agricultural labourers, as more than these at present employed are required to work the land properly, and even now farming on a scale at all commensurate with our needs as a nation is not an economic proposition. However, with the aid of electricity on the farm better results can be obtained with existing labour, and certain profit assured. The booklet by R. Borlase Matthews on this subject, published by the Electrical Development Association, has excited a good deal of interest in certain agricultural journals and there is evidence that farmers and estate owners are impressed by the arguments set forth. The time is therefore ripe on all counts for supply engineers in all districts to do everything possible to encourage development of the use of electricity on the land. Cheap overhead transmission lines can be erected and portable motors of 15 h.p., 5 h.p., and 3 h.p. will be found to meet general requirements, with a ½ h.p. motor for milking. Besides the saving in time and man-power there is the advantage of being able to have electric light in the farmhouse and outbuildings, the possibility of electrical crop treatment, etc. If a supply cannot be obtained there is always the alternative of the private oil-engine driven dynamo set, though where a supply can be purchased it has many advantages.

Farmers in other countries have found the use of electrical machinery most beneficial, especially so in non-belligerent countries during the war, and that very small farmers benefit as much as larger ones is evident from the very extended use of electricity for farming operations in Switzerland, where the farms are all on a small scale.

ECONOMY IN ELECTRICAL DEMAND.

The following extract from a statement made by Mr. L. L. Elden (Electrical Superintendent, Edison Electric Illuminating Co.) has been brought to our notice. It is taken from a brochure entitled "Water-Power and Fuel Problems," reprinted from the 10th Annual Report of the Commission of Conservation, Canada:—

> "As a means of smoothing out the load curve, staggered hours for closing appear to offer great promise. A recent investigation made in Boston showed that at least 15,000 kw. in generating capacity would be saved on the system of the Edison Elec. Illuminating Co. *if 30 industrial establishments would change their working hours by 30 minutes.* Fifteen thousand kilowatts represents about one-sixth of the total estimated peak load of the Boston system for this winter. The comparatively small change in closing hours required to effect such *a large* increase in available capacity is very striking."

The above reasoning, of course, applies equally to this country, and it is surprising that more has not been done on the lines suggested. Naturally, too, additional comfort in travelling would be secured and further economy in transport. We are all too well aware of the overcrowding now experienced, this being worse than in 1914, in spite of improved facilities, and is due to the prevailing desire for uniformity, including uniformity in times of going to and returning from labour.

Llandaff.—The R. D. Council are inviting tenders for feeder and distributing cables with services for 800 houses.



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Various Items.

New Supply Co.—A company under the title of Sennybridge Electric Supply Co. has been formed with a capital of £1,500 in £25 shares, to carry on at Devynock, Brecon, the business of suppliers of electricity.

"Faraday House Journal."—We acknowledge receipt of Vol. IX., No. 3, containing notes on various matters of interest to Old Faradians, besides little articles on the Uniflow steam engine and on A.C. over-pressures to earth on D.C. systems.

Swansea.—A two-ton electric truck with two-ton trailer, manufactured by the British Electric Vehicle Co., Ltd., has been taken into service at the dock tin plate sheds and is proving most satisfactory and economical.——A sub-station is to be erected at Morriston at a cost of £225.

Mica and Molybdenite.—Samples of large sheet mica and molybdenite have been received in the Dept. of Overseas Trade, 35, Old Queen Street, Westminster, S.W.1, from Chile, through the Commercial Sec. to H.M. Legation at Santiago, and may be inspected by U.K. firms interested on application to the Dept.

Batti-Wallahs.—The last of the luncheon meetings before the summer recess takes place on Monday, the 20th inst., at the Holborn at 1 o'clock, when it is hoped there will be a large gathering. Concrete suggestions for furthering the objects of the Society are particularly invited at this meeting. There will be no speaker, Society matters only constitute the business.

Damascus.—We learn that the market is at present still rather over-stocked with most commodities, and the steady rise in the rates of the Egyptian (and consequently the English) pound to local gold has resulted in British goods bought previously fetching smaller prices in Syria than in the U.K. At present most orders are going to countries where the exchange is low—Germany, Austria and Italy. It is thought, however, that when stocks are exhausted there may again be a limited demand for "good" quality goods, including electric light fittings and shades. It is not possible to compete in the cheaper qualities.

Inst.E.E. Premiums.—The full list of Premiums awarded by the Council of the Inst.E.E. for papers read before or published by the Institution during the past session is:—The Institution Premium, Mr. E. A. Watson, O.B.E.; Ayrton Premium, Sir P. Dawson; Fahie Premium, Sir W. Noble; John Hopkinson Premium, Mr. G. A. Juhlin; Kelvin Premium, Prof. E. Wilson; Paris Premium, Mr. K. Baumann; Webber Premium, Mr. J. Paley Yorke; The Duddell Premium, Mr. B. S. Gossling; Extra Premiums, Messrs. S. Evershed, W. B. Woodhouse, R. O. Kapp, A. E. McColl, G. E. Bairsto, D.Sc., M. B. Field, O.B.E., A. McKinstry, B.A., M.Sc.; and A Wireless Premium, Captain R. C. Trench.

French Co. to take over Ecuador's Telephones.—According to *Vie Financiere*, the Compagnie Générale de T.S.F. has concluded a contract for a period of 30 years with the Govt. of Ecuador for the working of the telephones, telegraphs and wireless service in that State. The Govt. will pay the Co. an annual subsidy of 430,000 sucres (about 1,200,000 francs), which will be increased in the event of any extension of the system. The Co. will deduct from the gross receipts the sums necessary for the working of the lines, for the payment of interest on the capital invested in the concern and for the sinking fund. The State will have a share in the net profits. The telephonic apparatus will be automatic, on the French model, as is that for the telegraphic and wireless operation.

Transvaal.—Tenders are invited by the Barberton Municipality for (1) Two steam boilers, each capable of giving 3,000 lb. of steam per hour at 180 lb. pressure. (2) Two alternators, each giving 75 kw. three-phase at 2,200 volts, 50 periods, direct coupled to high-speed engines. (3) Switchboard and instruments. (4) Boiler and engine-house auxiliaries, including steel chimney, piping, feed pumps and connecting cables. (5) System of distribution, including steel poles, conductors, insulators, lightning arresters, fuses and accessories. (6) Transformers for 2,900 to 240 volts, three each of 30 k.w. three-phase, and ten each of 5 kw. single-phase. (7) House services, meters, conductor and tubing for 150 consumers. Specifications may be obtained from Professor W. Buchanan, 75, Louis Botha Avenue, Johannesburg, on payment of two guineas, which is returnable on receipt of proper tender. Sealed tenders, endorsed "Electrical Plant," to be in the hands of the Town Clerk, Municipal Offices, Barberton on or before the 20th July.

Trade Notes.

The London Electric Firm (Brighton Road, Croydon) announce that they keep very considerable stocks of all kinds of searchlight mirrors, viz., parabolic, Mangin, metal, Suez and Panama type, also diverging lenses and front glasses. Consequently emergency orders can be promptly executed.

A new season's pocket catalogue of electric fans and small power motors has just been issued by the **Sun Electrical Co., Ltd.** (118-120, Charing Cross Road, W.C.2). The catalogue covers all the more usual types of fans, including ventilating fans for large volumes and powers, and ceiling fans. The small power motors priced are D.C. $\frac{1}{80}$ to $\frac{1}{4}$ h.p.

One of the most recent and at the same time important of the E.D.A. publications is the booklet "Electricity on the Farm," to which we have already made brief reference. We now learn that the **Electric Development Association** (Hampden House, Kingsway, W.C.2) has recently added a considerable number of interesting and up-to-date views to its collection of lantern slides dealing with the use of electricity on the farm, and it is to be hoped that full advantage will be taken of them in the campaign for the more extended use of electricity.

Geo. W. Wheatley and Co., Ltd. (formerly Waghorn), General Shipping, Insurance and Passenger Agency and Globe Foreign Express (London Office, 95, Upper Thames Street, E.C.4), send a booklet showing at a glance the cost of telephone calls under the new method of charging by distance between subscribers connected with the inner London zone exchanges. There is also a list showing the cost of a call to points outside the 1½d. limit within a radius of 25 miles of London and a schedule showing the various London exchanges between any of which the call fee is 1½d. Copies can be obtained free on application.

In addition to the new price list of "Freezor" fans already referred to, the **G.E.C.** has produced a "Freezor" fan folder, No. V2543, and a striking show card, in colours, measuring 19½ in. by 14½ in. The Co. offers quantities of folders over-printed with re-seller's name and address, adhesive advertisement stamps for attaching to correspondence, etc., and, to aid further the Trade in creating and stimulating demand, the Co. announces that it is prepared to loan advertisement blocks, submit suggestions for advertisements in local papers, etc., where re-sellers desire to undertake local advertising.

Williams, Pell and Baring (Old Sergeant's Inn Chambers, 5, Chancery Lane, W.C.2) have been appointed sole agents for the U.K. for the sale of electrical machinery and apparatus made by the Heemaf Co., of Hengelo, Holland. The Heemaf Works were established 18 years ago, and are now equipped with the most complete and up-to-date machinery for the rapid and economical manufacture of all electrical apparatus, particularly 3-phase motors and generators, controllers, switch-gear, switch-fuses and junction boxes, overload switches, synchronisers, automatic regulators and tungsten arc rectifiers, on which, we are advised, a staff of nearly 2,000 hands are constantly employed. Messrs. Williams, Pell and Baring intimate that they will willingly supply particulars, prices and dimensions of the Heemaf Co.'s manufactures to any of our readers.



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A PRACTICAL TRADE JOURNAL
JUNE 24, 1921.

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ELECTRO-PLATING.

By C. Sylvester, A.M.I.E.E., A.M.I.Mech.E.

(*Continued from page* 263.)

Voltmeters.—When only one bath is used it is not necessary to consider the generator voltage, beyond applying the correct voltage to the bath terminals as required by the articles that are being plated. Where there are several baths, however, each one requiring a slightly different voltage, it is necessary to insert regulating resistances in series with the baths, and it is also essential that the voltage of each bath should be known.

To ascertain this it would be a very expensive matter if a separate voltmeter were fitted to each bath, to say nothing of the time it would occupy to be continually passing from one bath to another. To overcome this a special voltmeter, illustrated in Fig. 7, is designed for reading the voltage

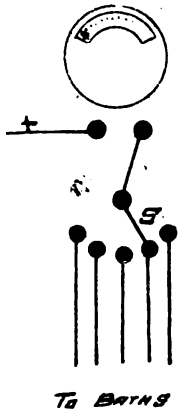


Fig. 7.

of any number of baths. As will be seen from the illustration, by means of a switch, S, the voltage of any one of five baths may be read at any time. One terminal of the voltmeter is connected direct to the positive side of the generator, the other terminals being taken to the negative side of the baths whose voltage it is desired to measure. As far as is possible, the voltmeter should be placed in such a position that the length of the voltmeter leads to each bath are approximately the same. This is necessary, because the voltmeters, being of the low reading type, a flucuation in the resistance of the leads must lead to a fluctuation in the voltmeter readings. In other words, the voltmeter reading will not be a true indication of the voltage at the bath terminals.

Anode and Cathode Carriers.—This is a matter of extreme importance, since upon their design and construction the efficiency of the plant will depend. The writer has seen several well-designed plants which were installed during the war to meet the requirements of copper-plating for aero-engine parts, and the only bad point appeared to be the design of the element carriers.

In the first place, these should be sufficiently strong to support the heaviest element it is likely to use. There should be no bending of the carriers when the elements are placed upon them. Copper and brass rods are generally used—the thicker they are the better they are, when heavy articles have to be plated, such as boiler tubes, etc.

With some plating plants it is common practice to fix porcelain insulators on each side of the bath. These insulators are similar in construction to the bridge pieces so much used for cable work. The rods, to carry the anodes and cathodes, are placed on these bridge pieces and it is considered that all requirements have been met. This is not so, however, because the bridge pieces, being a fixture,

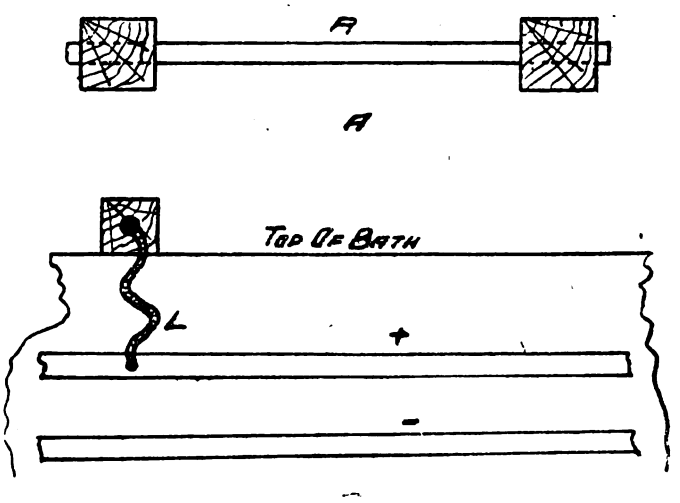


Fig. 8.

also make the rods a fixture, except for the fact that, after a stud has been unscrewed from each end of the rod to release the connection from the dynamo, each rod may be removed bodily from its position on the top of the bath.

This method is very inconvenient, because it should not be necessary to bodily remove any rod to allow the insertion in the bath of any large articles to be plated. The rods should be capable of movement with a minimum amount of inconvenience, and an excellent method of allowing the movements of rods, without any interruption of the circuit is illustrated in Fig. 8.

In this diagram the upper portion, A, shows a rod, R, upon the ends of which two wooden blocks are placed. These blocks should not be a tight fit, merely a sliding fit, and they may be fixed in position by means of a set screw according to the length of the bath. A hole is drilled and tapped in each end of the rod to receive a screw, the function of which is to carry a conductor from the bars to the rods.

Since the rods are to be capable of movement without the electrical connections being affected, it is necessary to connect the rods, by means of flexible cables, to the bars. This is illustrated at B in Fig. 8. Here the end of the rod is shown connected to the positive bar by means of the flexible L. The limit of travel is, of course, the length of the flexible lead, but twice this distance can be obtained if the adjacent rod be moved in the opposite direction.

The wood used should be ash, as this is very hard and will not absorb the water very easily. The nipples connected to the ends of the flexible cable should not be soldered, but should be pressed on to the cable by hydraulic pressure, similar to the bond heads used between rails in a traction system. It is hardly necessary to say that the

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rods themselves should be always kept quite clean, and not covered with verdigris as is the case with some plants known to the writer.

Of course, it may be that the whole of the rods across a bath are not filled. When this is so, after they have been cleaned, it will not do any harm if the rods are very lightly covered with vaseline. It will not cause much inconvenience to remove the vaseline when it is necessary to fill the rods. Considerable care should be given to the flexible cables and their connections to the bars and rods. It will be found that, in time, some of the strands will be broken, due to the continual movement of the rods across the top of the bath. When this occurs the remaining strands have to carry more current and are likely to get overheated. There is only one result to this—increased resistance in the circuit and a loss of generator voltage.

(To be continued.)

THE BRITISH ELECTRICAL CABLE INDUSTRY.

REPORT OF COMMITTEE ON TRUSTS.

The Report on the British Electrical Cable Industry prepared by a Sub-Committee appointed by the Standing Committee on Trusts, under the Profiteering Acts 1919 and 1920, has now been issued and may be obtained from any bookseller or from H.M. Stationary Office at its various addresses for the sum of 1d.

The summary of findings is as follows:—

(*a*) The committee finds no combination of manufacturers controlled by one central organisation from the point of view of capital and output, but there are in the industry or connected with the industry several associations, of which the principal are the Cable Makers' Association, the Telephone Cable Makers' Association, and the High Conductivity Copper Association

(*b*) Arrangements are made amongst the members of associations as to the prices to be charged for their products.

(*c*) The C.M.A. has been largely instrumental in creating and maintaining the prosperity of the industry in this country, and its operations have been favourable to the improvement of quality.

(*d*) There are manufacturers operating outside the association who are in a position to compete to a substantial extent with the members of the association, and the prices charged by non-associated firms may fairly be stated to be generally about 10 per cent. lower than those of associated firms. From the point of view of quality the evidence is conclusive that certain non-associated firms are able to produce cables no less reliable than the productions of associated manufacturers, but the outstanding fact remains that the largest purchasers, as a rule, are content to pay the additional price as in the nature of an insurance against interruption of electricity supply from failure in service, and as a guarantee of durability.

(*e*) From the evidence there is no cause to believe that any of these associations have acted unreasonably, and the committee are of opinion that, even should there be any risk of their acting unreasonably in the future, a sufficient safeguard for the public would exist if effect were given to the recommendations contained in the report, dated April 24, 1919, of the Committee on Trusts.

The prosperity of the industry is demonstrated by the financial position of the principal manufacturers concerned and by the dividends paid over a course of years. There is no doubt that this prosperity was largely created by the C.M.A., which, by its organisation and research, initiated, and has since maintained, a high standard of quality, thus securing the confidence of buyers both in this country and abroad

OIL FUEL.

In the issue of the *Tramway and Railway World* for June 16 particulars are given of the substitution of oil-fuel for coal in the generating stations supplying the tramways at Hull, Barrow-in-Furness, Blackpool, Bristol, Newcastle-upon-Tyne, Blackburn, Croydon, Edinburgh, Bath, Southend, Preston, Ipswich, Sheffield, Glasgow and Leeds. Reference is also made to the L.C.C. tramway station at Greenwich. The fullest information is given for Hull by Mr. E. S. Rayner, and comparative figures show that the total cost per unit generated with coal was 0.86d. and with oil 1.223d., in each case a test period of 14 days being taken. The cost of oil was £5 5s. per ton and of coal (of pre-strike quality) £2 2s. The figures have therefore no absolute comparative value. Taken all round the results are very satisfactory and the following conclusions are worth noting:—As regards the cost of labour in handling the respective fuels, the advantage undoubtedly lies with oil, though the extent of the saving will vary considerably according to the method of handling the coal. In small generating stations, where hand stoking has been the rule, oil should easily hold its own, though in the larger power-houses, with mechanical stokers, the economy in handling costs will not be so marked. In the case of Blackpool, where an auxiliary oil-burning equipment was provided for before the miners' dispute began, Mr. Furness considers that unless the price of coal falls below £3 per ton it will probably be to the advantage of the Corporation to maintain the use of oil. After all, the coal trouble may prove—we would not say a blessing in disguise—but a means towards the fuller recognition of this other great source of power. There is little doubt that oil will become cheaper as new fields all over the world are exploited. As a stand-by, and a means of coping with peak loads, oil fuel seems to have definitely asserted its utility.

THE ENGINEERING SLUMP.

At the present time French, German and Belgian engineering (and in fact most other) industries are working at top pressure, and by hard work coupled with harmonious co-operation between Capital and Labour these countries are building up their maimed or sleeping export trade. For example may be cited the receipt of several large orders from abroad by the Rheinmetall-Lokomotivbau (Dusseldorf) for locomotives, including a large order from the Roumanian Government for goods train locomotives. Three months after the receipt of this order five locomotives of the heaviest build left the works for Roumania. This concern has developed in such a way that 30 locomotives and 300 wagons are leaving the works daily. By February the 1,000th goods truck had been delivered, and at the beginning of March the 100th locomotive left the factory.

On the other hand there is nothing at the moment to be said favourably of the industrial situation at home—the course of events being of such national interest that the situation is fully dealt with in the large "dailies." Although on the surface the position looks very black we have hope that, actually, the Labour extremists are being finally beaten, and that the next few weeks, if not days, will see sanity once more established.

We will not again labour the point that we are not producing cheaply enough to sell our products in this or any other country, although the demand for goods of all kinds exists. However the coal dispute may be settled, at some time, in the not very distant future, masters and men in the engineering trades will be compelled by the pressure of stern necessity to compose their differences and agree upon a *modus vivendi*. All their thoughts and energies will be needed for the task of salving the industry by which they live. Delay in making this great constructive effort will merely increase the amount of leeway to be painfully and laboriously recovered, and imperil the chances of ultimate success.

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POINTS ON THE CARE OF DYNAMOS AND MOTORS.

ARMATURE AND FIELD MAGNETS.

(1) See that these are kept free from damp, and that no water drips or splashes on them.

(2) Any parts where dust or dirt is likely to gather should be frequently cleaned by a pair of bellows.

(3) The yoke and pole pieces of the field magnets—part of the magnetic circuit—should receive careful treatment; avoid striking them with metal of any kind.

(4) See that the various parts are kept cool. If the armature is carrying an excessive current, or if the ventilation is poor, the insulation may be damaged.

(5) Clean the armature and re-set brushes after a period of running.

(6) Keep articles made of iron away from the armature.

COMMUTATOR.

(1) Keep this clean and true. A blackened commutator spells undue sparking. When cleaning, do so when it is running. This avoids forming a "flat" on the curved surface. Should this form by any chance, the commutator must be turned down true in a lathe.

(2) Use a cloth with a little mineral oil on it for cleaning, or very fine glass paper. On no account should emery paper be used.

(3) Move the brush-holder along the rocker, so that the wearing of the commutator takes place evenly.

SPARKING TROUBLES.

The following are the causes of sparking at the brushes:—

(1) Overload.
(2) Bad setting of brushes, or making poor contact.
(3) Roughened commutator, or being out of truth, or high or low commutator bars.
(4) Dirty brushes or commutator.
(5) Worn bearings or worn commutator.
(6) Bent armature shaft.
(7) Reversed armature coil.
(8) Weak field.
(9) Earth connection.
(10) Vibration or a slipping belt.

In (1) the armature will run hot. In this case, move the brushes forward for a dynamo and backward for a motor.

In (2) the brush spindles have not been set geometrically, or the brush may not move freely in the holder. The spring pressing on the brush may not be at the right tension, or the holder may have shifted on the spindle.

In (3) the commutator may have had bad treatment, or the mica segments may not be of equal hardness. Turn the commutator up true and polish it. For high or low bars there is a break in the circuit. In a high bar the brush is lifted from the other segments, and in a low bar there is a depression in the surface of the commutator.

In (4) the brushes may be too soft, or grease may have been used for cleaning the commutator.

In (5) the field is distorted by the armature being out of centre, or in the case of a worn commutator the brushes span more than the normal number of bars.

In (6) the commutator will run eccentrically, and this gives unequal pressure of the brushes.

In (7) a local current is set up, and more power is required to run the machine. It runs jerkily and the voltmeter reading is not steady.

In (8) a weak field may be caused by a field coil being in opposition or a short circuit or a bad magnetic joint This reduces the E.M.F. for a dynamo or the starting torque for a motor.

In (9), if the current is earthed at two points, the field or armature windings will be short-circuited. If earthed at one point the flow of current will not be much affected.

In (10) continuous sparking is set up when mechanical vibration occurs, and the various bases should be made firmer. For a slipping belt there will be speed variations. This causes intermittent sparking.*

* And be sure to obtain a copy of Broadbent's "Dynamo and Motor Attendants and their Machines" (Rentell, 4s. 6d. net), which covers the whole ground thoroughly.

LONDON'S ELECTRICITY SUPPLY.

The Electricity Commissioners are now in the throes of attempting to unravel once and for all the intricate problem of the supply of electricity in London and the adjacent areas. This has been the subject of continual discussion and contention ever since Mr. C. H. Merz introduced his Power Bill in Parliament in 1905, and it is now left to the Commissioners, although their powers are not quite so absolute as was at first intended when the Electricity Supply Act of 1919 was first introduced, to devise a scheme and to impose it upon what must be regarded as to some extent unwilling parties, for there are over 80 electricity supply authorities in the area which has been scheduled by the Commissioners as the one which they think should form the London electricity supply area. It was the expressed hope of the Commissioners a short time ago that an agreed scheme would be presented to them at this inquiry. Instead of such a scheme, they are faced with no fewer than six, and this has necessitated the inquiry being carried on for four days every week, viz., Tuesday, Wednesday, Thursday and Friday, in order to get through the business in a reasonable time.

Three of the schemes, viz., those by the London County Council; the Conference of Local Authorities Owning Electricity Undertakings in Greater London; and the London Electricity Joint Committee, 1920, Limited, aim at effecting an improvement in the existing means of supply in the area in question and for the formation of a Joint Electricity Board. A fourth scheme is by the Borough of Poplar, which seeks to deal with Poplar and the East of London as a self-contained proposition, whilst the fifth and sixth schemes are by the G.E.R. and the L.B. and S.C.R., respectively, and are said to aim at effecting an improvement of the existing organisation for the supply of electricity in the area scheduled by the Commissioners.

The Commissioners, presided over by Sir John Snell, decided to deal with the schemes one by one, and started on that presented by the L.C.C. This provides for the erection of four new generating stations, three of which would be on the Thames, to the east of Blackwall tunnel, and the fourth, also on the Thames but to the West, viz., at Chiswick. In addition, two of the existing power stations would be extended. The technical scheme included in the L.C.C. proposals is one which has been prepared by an engineers' committee consisting of Sir Alexander Kennedy and Mr. G. W. Partridge, representing the London companies, or at any rate a large number of them, Mr. J. H. Rider, representing the L.C.C., and Mr. C. H. Wordingham, representing the local authorities, whilst Sir Philip Dawson has approved the scheme on behalf of the railway companies. It will thus be seen that there is not much disagreement upon the engineering side, and, in fact, the whole course of the early stages of the inquiry indicate readily enough that it is the administrative side which is causing the deadlock. Municipal jealousies still exist, and we find Middlesex and Hertfordshire, for instance, as county councils, asking to be excluded. Then, again, almost everybody wanted direct representation on the Joint Electricity Authority which it is proposed to constitute. The L.C.C. suggests that this should consist of 28 representatives, or 29 if an outside Chairman is elected. Of these, the L.C.C. would appoint 8, the local authorities owning electricity works 6, the companies 6, the purchasing authorities outside the County of London and other local authorities 4, the railway companies 2 and the workers 2. It is suggested that the purchase powers now possessed by the L.C.C. over the London companies should be vested in the new Joint Authority, and the possibility of the latter body purchasing

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the undertakings at an earlier date than 1931 by agreement and then leasing them to the companies for a period of years—the companies themselves took up this point and suggested 60 years—was hinted at, with a view to delaying the expenditure of the large amount of capital which would be necessary if the purchase were to take place in the ordinary course in 1931. If such a course were adopted, the companies themselves, or at any rate a certain number of them, because all the London companies do not see eye to eye in this matter apparently, as they are represented by different counsel, spoke of the possibility of being able to provide a large sum of money for the Joint Authority to set about the work of reorganisation and construction, the L.C.C. guaranteeing the interest.

In general principle that is the L.C.C. scheme. Mr. G. Hume, who has been Chairman of the L.C.C. Electricity Supply Committee since it was first formed, gave evidence, apart from the technical aspect, which was spoken to by Mr. J. H. Rider and will be dealt with later. Apart from the matters mentioned, there is the question of deciding as to finding the expenses of the Joint Authority until the whole scheme is in working order and its expenses can be charged as part of the working costs of the supply in the whole area. The L.C.C. suggests that these preliminary expenses should be levied upon the existing undertakings in proportion to the units sold, and somewhat naively admits that this would not involve the L.C.C., as such, in any share of these expenses. That is naturally a matter of objection, as is also the large proportion of L.C.C. members upon the proposed Joint Authority. Although these, and others, are matters of detail, they are really the essential points in the whole controversy, rather than the general principle of linking up and the working out of the engineering details, which, however, are interesting in themselves.

(To be continued.)

PRESS ADVERTISING.

FOR ELECTRICITY SUPPLY AUTHORITIES AND CONTRACTORS.

A useful innovation has been made by the British Electrical Development Association (Hampden House, 84, Kingsway, W.C.2) in the form of a booklet, with the title of this note, by S. M. Hills. The object is to advise supply authorities and contractors as to the essential points to be borne in mind when drafting advertisement "copy" for the local Press, etc. A number of suggested advertisements are included in a form ready for sending to the printers. By taking advantage of these, undertakings not in a position to produce their own "copy" and blocks can be assured of their announcements having good business value. The E.D.A. Advertising Service provides copy, blocks, posters, leaflets, etc.; particulars being given in the booklet in question, which is No. 164 and is priced at 2s. 6d. net.

"STICKY" TAPE.

Although sticky tape has been made and sold by W. T. Henley's Telegraph Works Co., Ltd. (Blomfield Street, London Wall, E.C.2), ever since the need for such a tape arose, its sale has not been pushed to any great extent—although it was used by the manufacturers and a limited number of regular customers. The company has now, however, laid down a plant for its "mass production," so that its cost has been considerably reduced and is now below that of imported tape. Here is, therefore, every inducement for users to utilise it in preference to imported tape, and so help to level the exchange rate and provide additional employment in this country. Further, "Henley" sticky tape is packed in approximately net weight coils, not weight including wrapper, while the quality is of the same high standard as hitherto.

STAGE LIGHTING.

A special lamp designed for lighting the forepart of the stage, thus eliminating the necessity of the footlights, is described in the *A.E.G. Mitteilungen*.

The lamp consists of a large reflector totally enclosed with a lens in front of only 15 cm. diameter. These lamps are fixed high up in the fore part of the stage, one on either side. A rheostat for 10 amps., 110 volts, is provided to give gradual dimming of the light, and a large selection of colours can be obtained in very gradual steps.

This method has been adopted in the Lessing Theatre, Berlin, and is very satisfactory, and entirely does away with any sudden change of light intensity between the front and back of the stage. The source of light is invisible.—*Technical Review.*

THE LAKE COLERIDGE HYDRO-ELECTRIC SCHEME.

In the course of a recent address the New Zealand Minister of Public Works said that the Lake Coleridge power house was built at first as an experiment, but the results to-day showed that only a quarter of the power that could be used was being turned out. He pointed out that where the capacity of the plant was 8,000 h.p., at present 1,500 h.p. more than this amount was being run on the plant, which was getting near the danger point. Plant was being provided for another 4,000 h.p. at once, to be ready for winter use. With regard to the cost of the new plant, he was considering various tenders with a view to deciding which was in the best interests of the country. In 1922 provision would be made for another 4,000 h.p., which would bring the output of the Lake Coleridge power station up to 16,000 h.p. With regard to the distribution of power, he stated that 1,000 h.p. would be distributed on the Timaru line to Ashburton-Orari, and 500 h.p. to Banks Peninsular, Ellesmere and certain other outlying districts.

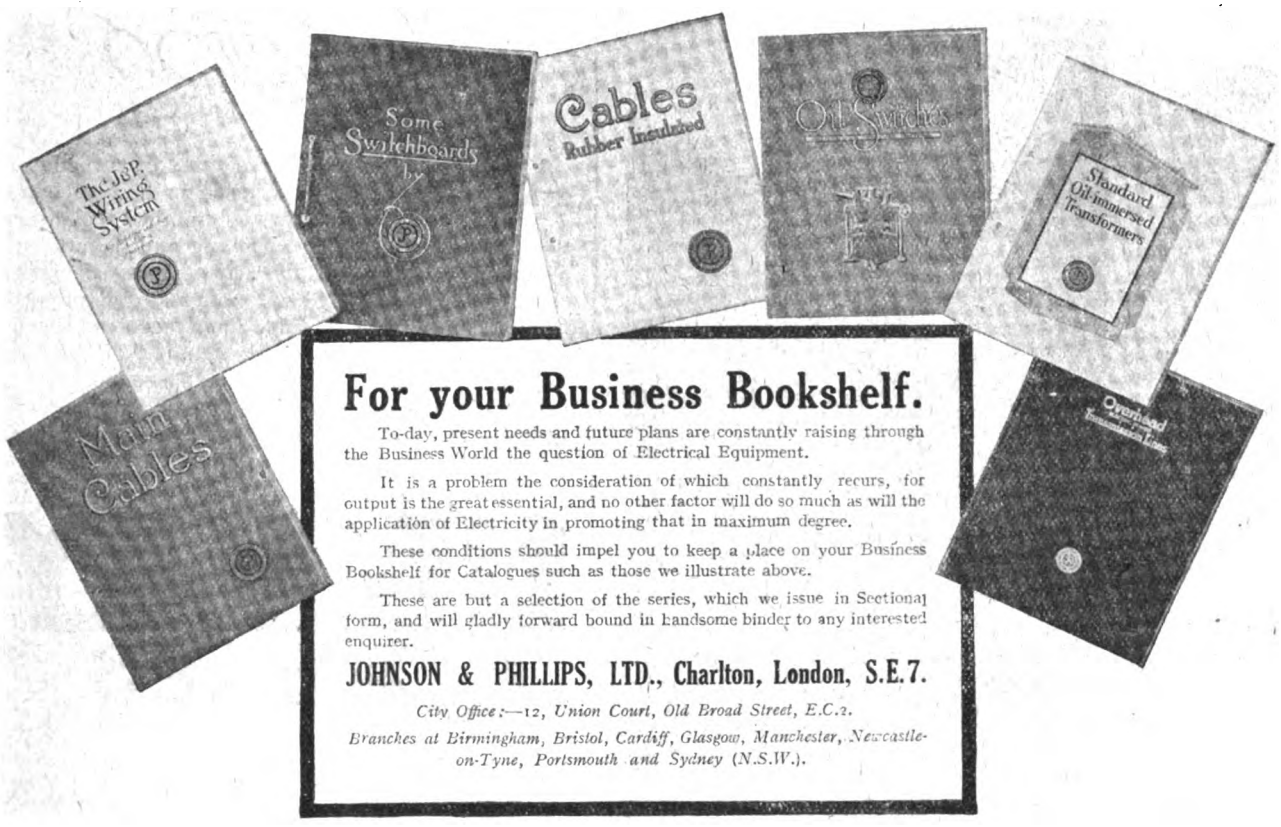
All the money which had been set aside for electrical extensions, £750,000, would be spent. The plans and specifications of the power house had been approved, but certain surveys remained to be made. A new 10-ft. tunnel and a pipe line would, when completed, result in a capacity of 36,000 h.p. It would be necessary also to double the capacity of the transmission lines to Christchurch and make an extension to South Canterbury and also to North Canterbury.

The Minister pointed out that Govt. operations were restricted only by the amount of money available, and there was nothing to prevent them going to the ultimate capacity of Lake Coleridge but lack of money. It was necessary, however, that the money available should be spent to the best advantage of New Zealand as a whole, and in connection with the various other schemes, Arapuni, Waikaramoana and Mangahao in the North Island, and Marlborough, Nelson, Westland and Otago, to be connected ultimately with Monowai (Southland) in the South Island. High prices and insufficiency of supplies and also of labour had delayed progress in the past.

Christchurch had received a considerable start over the rest of New Zealand in the industrial advantages it possessed due to electrical assistance it received from Lake Coleridge. The city had great possibilities with regard to its industries, and he had no doubt that if double power could be obtained from the lake, it could be sold.

Further Hydro-Electric Developments in France.—To render the Rhine navigable between the Swiss frontier and Strassburg a lateral canal 125 km. long is to be constructed. The fall is 106 metres, necessitating the building of eight locks, at each of which a hydro-electric station is to be erected. It is estimated that the combined maximum capacity will be 550,000 kw., which with 900,000 kw. available from the Rhone will enable France to cut down her pre-war coal imports by about 50 per cent., between 9 and 10 million tons per annum.

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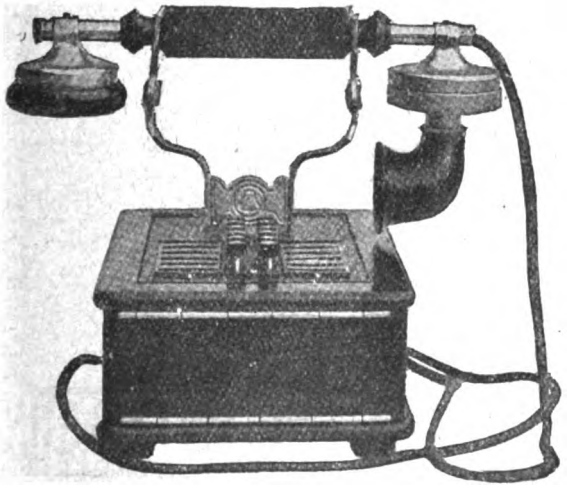
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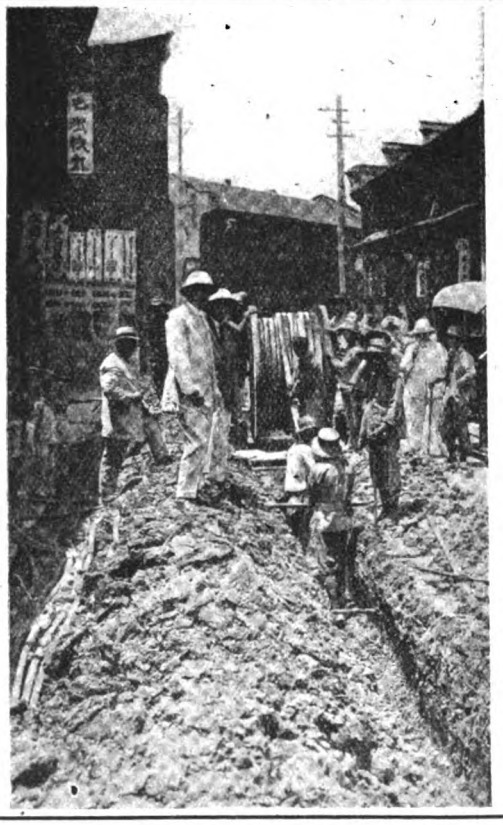
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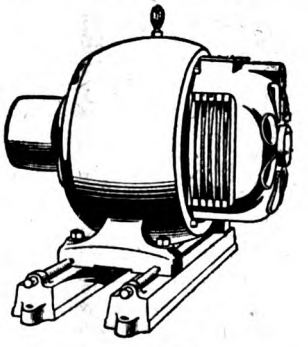
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Specimen advertisements are included which require only the insertion of advertiser's name and address.

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Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Salesmanship—A Neglected Opportunity.

The British manufacturer is proverbially mute with regard to the goods he sells, or tries to sell. He is gradually yielding to the arguments in favour of intensive advertising, but even so, he is yet far from getting the full value out of such publicity as is available to him at comparatively small cost. If any reader will reflect for a few minutes he will realise that there is scarcely any article or appliance exposed for sale which carries with it explicit directions for obtaining the best results from its use, or directing attention to its possibilities in directions other than the one for which it is expressly designed and marketed. Take the ubiquitous safety razor for example. Thousands of these have been sold, and there are still thousands of shavers who, having expended the money on a "safety," still stick to the old-fashioned kind, simply because they have not acquired the knack of getting the best results from the more modern and efficient article.

I will admit that I did not like a safety razor myself the first half dozen times I used it, but I persevered, and now I would not return to the old love on any account. There were no simple instructions issued with my razor by the manufacturer, or I should probably have mastered its tricks inside the first five minutes instead of having to find out by experience. It is the same with practically all mechanism and labour-saving devices. Some ingenious individual conceives the idea and has it carried out by a competent manufacturer, and the goods are ultimately placed on the market without a word as to the means of obtaining maximum efficiency. One sees a plate marked "oil," but one is not told when or how often to apply lubrication, what kind of oil is best suited to that particular movement, what quantity to apply, or anything else beyond the fact that there is an orifice and that it is intended for the reception of oil. As a practical outcome I have seen a big engine-room oil-can half-emptied into a near-by commutator inspection opening, to the great detriment of commutation.

A certain firm of my acquaintance bought one of the small rotary printing outfits the other day for use in circularising its customers. There were no instructions issued with this somewhat complex mechanism, and, although a girl was sent to give practical demonstrations at the outset, the ultimate operator was left to gain her experience as best she could. The purchaser tackled the salesman on this point and was told that it was the policy of the makers of the machine not to issue comprehensive instruction booklets because it tempted users to tamper with the adjustments unnecessarily. My friend insisted on a booklet and ultimately obtained one, after experiencing all kinds of initial difficulties in the use of the machine. Intelligent application of the hints given in the book has since resulted in excellent printing, and the essential adjustments are now thoroughly understood and maintained.

What is true of the simple devices is equally applicable to the more complex installations. Take a collection of electrical devices, such as are incorporated in an elaborate power switchboard for example. Such a board probably bears components emanating from several different makers, each specialising in his own particular product. Circuit-breakers, voltmeters, ammeters, fuses, interlocking gear, etc., all enter into the constitution of such a switchboard, and each piece of mechanism or instrument has its own particular adjustments and settings designed to give the best results. All these should be passed on to the ultimate user in clear and comprehensive terms, illustrated if necessary by diagrams. In those rare cases where instruction labels are attached to components which are going to be assembled by another manufacturer they should be left *in situ* for the benefit of the customer, and not detached or lost.

A specific and particular case is that of storage batteries, which form a part of so many electrical installations of one kind or another. The storage battery maker is the best judge of how his product should be handled and maintained, and any instructions he may issue with his batteries should be handed on intact and without modification or addition to the ultimate user, who is then in a position to fix the blame in the proper quarter if the battery does not function satisfactorily. I know of one case where a customer put sal-ammoniac into a set of accumulators because the voltage of his system was low and it was the only way in which he had seen electric batteries of the front-door bell variety brought up to scratch by the local plumber-electrician. Needless to add, no specific instructions had been issued with that battery.

It is quite easy to understand this failing on the part of the average manufacturer in properly educating his clients up to the use of the appliances he manufactures.

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The maker himself is a specialist, and is so familiar with his own goods, as are also his staff, that they are all apt to think that every customer is equally familiar with their products. They instinctively carry out the necessary offices in connection with adjustment and maintenance, and quite overlook the fact that the average buyer has probably never seen the product before, and is quite a novice in handling it. The idea of a brief elementary treatise on its functions appeals to them as childish and unnecessary owing to their very familiarity. To compile a satisfactory set of instructions it is necessary for the expert to mentally place himself in the position of the novice purchaser, and realise for the moment that he is absolutely ignorant of the why and wherefore of every detail. It is not an easy task, and it is sometimes better to call in the services of an outsider in compiling such data.

Zoological Breakdowns.

It was a fresh-water eel which some time ago held up the electricity supply of Bettws-y-Coed, and now it is reported that a real sea-going conger was responsible for deranging the force-pump and stopping the tramways at Plymouth. Quite recently at the same town a live rat created a dead short by establishing contact with a "quick" wire. If the usual lay reporter gets to work on this we shall probably hear the tale of the (amp)-hare which volted over the squirrel-cage motor and went to earth in the condenser after pinching all the currents. Watt?

A Clear Conscience.

The difference beween "Trusts" and legitimate trade "Associations" is admirably exemplified in the recently published report of the sub-committee appointed by the Standing Committee on Trusts which has investigated alleged profiteering by cable makers. There are three principal associations concerned, viz., the Cable Makers' Association, the Telephone Cable Makers' Association, and the High Conductivity Copper Association, all of which arrange among themselves the ruling market prices of their respective commodities. The sub-committee find that the C.M.A. has been largely instrumental in creating and maintaining the prosperity of the industry in this country, and that its operations have been favourable to the improvement of quality. From the evidence before them, the sub-committee have no cause to believe that any of these associations have acted unreasonably, and the higher prices charged in some instances are willingly paid by the largest cable users as an insurance against interruption of electricity supply through cable breakdown and as a guarantee of durability. Experiences with Continental cables in this country amply bear out the committee's findings.

ELEKTRON.

Outing.—The Bristol, Cardiff, and Swansea staffs of the Edison Swan Electric Company, Ltd., held their annual outing on the 8th inst., when the Wye Valley was visited by motor coach. Leaving Bristol at 9.30 a.m., Tintern was reached about three o'clock, and the company, numbering about 70, indulged in various sports until tea-time. After tea, which was held at the Royal George Hotel, an impromptu concert very agreeably occupied the time until 6.30, when the return journey was commenced, Bristol being eventually reached about 11.30 p.m.

ELEMENTARY DETERMINANTS

WITH SPECIAL REFERENCE TO KIRCHHOFF'S LAWS.

By H. P. FEW,
Silver Medallist in Telegraphy, etc.

TENTH ARTICLE.

NOTE.—The aim of these articles is to bring out prominently the advantages of employing determinants, in conjunction with Kirchhoff's laws, for finding current values in complicated networks of conductors. The previous articles appeared in our issues of June 25, August 6 and 27, September 17, October 22, December 3, 1920, February 25, March 25, and May 6, 1921, and gave an account, *inter alia*, of Kirchhoff's laws and corollaries, Maxwell's cyclic equations, general methods of evaluating determinants, application of determinants to finding current values in simple networks, including the Wheatstone Bridge, Thomson double bridge, bridge duplex system of telegraphy, etc. This article deals with the "leak" system of telegraphy.

In this article we employ the methods of determinants for finding the values of the currents passing through the receiving instruments of a number of telegraph stations, all connected in "leak" and all supplied by working current from a single battery at the head office :—

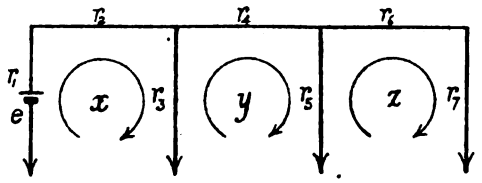


FIG. 23.

The skeleton connections of a 4-office system are shown in FIG. 23, where r_1 represents the resistance of the head office apparatus, including that of the battery of electromotive force e; r_3, r_5 and r_7 are the resistances of the apparatus at the out-stations, and r_2, r_4 and r_6 are the respective line resistances between the offices.

Our object is to find the values of the currents which will be available for operating the receiving instruments at each of the out-stations.

Let x, y, and z be the cyclic currents flowing in the meshes as shown in the figure. Then by Maxwell's rule we form the three equations—

$$\begin{aligned} x(r_1+r_2+r_3) - y r_3 &= e \\ -x r_3 + y(r_3+r_4+r_5) - z r_5 &= 0 \\ -y r_5 + z(r_5+r_6+r_7) &= 0 \end{aligned}$$

Forming the determinant for x—

$$x = \frac{\begin{vmatrix} e & -r_3 & 0 \\ 0 & (r_3+r_4+r_5) & -r_5 \\ 0 & -r_5 & (r_5+r_6+r_7) \end{vmatrix}}{\begin{vmatrix} (r_1+r_2+r_3) & -r_3 & 0 \\ -r_3 & (r_3+r_4+r_5) & -r_5 \\ 0 & -r_5 & (r_5+r_6+r_7) \end{vmatrix}}$$

and expanding and multiplying out, we get—

$$x = \frac{e\{(r_3+r_4+r_5)(r_5+r_6+r_7)-r_5^2\}}{\{(r_1+r_2+r_3)(r_3+r_4+r_5)(r_5+r_6+r_7)-r_5^2(r_1+r_2+r^3)\}-r_3^2(r_5+r_6+r_7)}$$

$$= \frac{e\{(r_3+r_4)(r_5+r_6+r_7)+r_5(r_6+r_7)\}}{\{(r_1+r_2)(r_3+r_4)+r_3 r_4\}(r_5+r_6+r_7)+r_5(r_6+r_7)(r_1+r_2+r_3)}$$

Forming the determinant for y—

$$y = \frac{\begin{vmatrix} (r_1+r_2+r_3) & e & 0 \\ -r_3 & 0 & -r_5 \\ 0 & 0 & (r_5+r_6+r_7) \end{vmatrix}}{\Delta}$$

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where the denominator Δ is as before. Thus—

$$y = \frac{er_3(r_5+r_6+r_7)}{\Delta}$$

The determinant for z is—

$$z = \frac{\begin{vmatrix} (r_1+r_2+r_3) & -r_3 & e \\ -r_3 & (r_3+r_4+r_5) & 0 \\ 0 & -r_5 & 0 \end{vmatrix}}{\Delta}$$

which gives—

$$z = \frac{e\,r_3\,r_5}{\Delta}.$$

and this gives the current flowing through r_6 and r_7, *i.e.*, through the receiving instrument at the out-station farthest from the head office. To find the current flowing through r_3, *i.e.*, through the first out-station's apparatus, we must subtract the y-cyclic current from the x-cyclic current, thus—

$$x-y = \frac{e\{(r_3+r_4+r_5)(r_5+r_6+r_7)-r_5^2-r_3(r_5+r_6+r_7)\}}{\Delta}$$

$$= \frac{e\{(r_4+r_5)(r_5+r_6+r_7)-r_5^2\}}{\Delta}$$

$$= \frac{e\{r_4(r_5+r_6+r_7)+r_5(r_6+r_7)\}}{\Delta}.$$

To find the current flowing through r_5, *i.e.*, through the second out-station apparatus, we may subtract the z-cyclic current from the y-cyclic current, thus—

$$y-z = \frac{e\{r_3(r_5+r_6+r_7)-r_3r_5\}}{\Delta}$$

$$= \frac{er_3(r_6+r_7)}{\Delta}$$

Suppose $r_2=r_3=r_4=r_5=r_6+r_7=r$, then the denominator

$$\Delta = \{(r_1+2r)(3r)(2r)-r^2(r_1+2r)\}-r^2(2r).$$
$$=(r_1+2r)\,5r^2-2r^2$$
$$=r^2(5r_1+8r)$$

$$\therefore z = \frac{er^2}{\Delta} = \frac{e}{5r_1+8r} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$y-z = \frac{e(2r^2)-er^2}{\Delta} = \frac{e}{5r_1+8r} \quad \ldots\ldots\ldots\ldots (2)$$

and

$$x-y = \frac{e\{(3r.\,2r-r^2)-2r^2\}}{\Delta}$$

$$= \frac{3er^2}{r^2(5r_1+8r)} = \frac{3e}{5r_1+8r} \quad \ldots\ldots\ldots (3)$$

This case obtains in practice on a 4-station direct-current circuit with universal connections joined to a concentrator. The resistances of the sections of line between the out-stations are made as nearly as possible equal, and also equal to the leaks. Fig. 24 shows a typical circuit where the head office key is depressed.

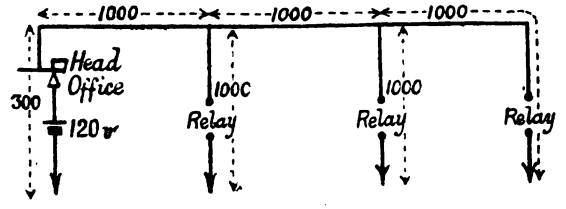


FIG. 24.

Here $r_1 = 300$, $r = 1000$, and $e = 120$ ohms.

From (1) $z = \frac{120\times1000}{(5\times300)+(8\times1000)} = 12.63$ milliamperes, which is the current through the last station.

From (2) $y - z = z = 12.63$ milliamperes, which is the current through the second out-station.

From (3), $x-y = \frac{3\times120\times1000}{(5\times300)+(8\times1000)} = 37.89$ milliamperes, which is the current through the first out-station.

The current passing through the battery at the head office is—

$$(x-y)+(y-z)+z = x$$
$$= 37.89 + 12.63 + 12.63 = 63.15 \text{ milliamperes.}$$

To find the resistance of a system of conductors such as shown in Fig. 23, we note that the joint resistance of the conductors from the last junction is—

$$= \frac{r_5(r_6+r_7)}{r_5+r_6+r_7}$$

and from the preceding junction the joint resistance is—

$$r_3 \frac{\{r_4(r_5+r_6+r_7)+r_5(r_6+r_7)\}}{(r_3+r_4)(r_5+r_6+r_7)+r_5(r_6+r_7)}$$

and finally for the whole system of conductors we find the joint resistance is—

$$R = \frac{(r_1+r_2)\{(r_3+r_4)(r_5+r_6+r_7)+r_5(r_6+r_7)\}+r_3\{r_4(r_5+r_6+r_7)+r_5(r_6+r_7)\}+r_3r_4(r_5+r_6+r_7)+r_3r_5}{(r_3+r_4)(r_5+r_6+r_7)+r_5(r_6+r_7)}$$

$$= \frac{\{(r_1+r_2)(r_3+r_4)+r_3r_4\}(r_5+r_6+r_7)+r_5(r_6+r_7)(r_1+r_2+r_3)}{(r_3+r_4)(r_5+r_6+r_7)+r_5(r_6+r_7)}$$

$$\therefore x = \frac{e}{R} = \frac{e(r_3+r_4)(r_5+r_6+r_7)+r_5(r_6+r_7)}{\{(r_1+r_2)(r_3+r_4)+r_3r_4\}(r_5+r_6+r_7)+r_5(r_6+r_7)(r_1+r_2+r_3)}$$

a result already obtained. In the foregoing method of obtaining the equivalent resistance, the quantities to be operated on become more and more unwieldy as the number of leaks increases. The above example is a particular case of the general one of a telegraph line from which the current leaks over the insulators or through the insulating medium. In Fig. 25 let PQ be

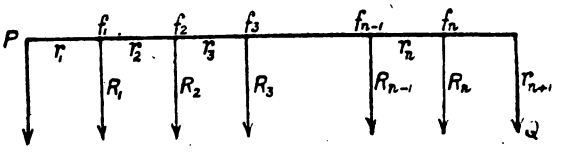


FIG. 25.

a telegraph line with leaks of resistance R_1, R_2, ... R_{n-1}, R_n, and let the resistances of the sections of line between the successive leaks be r_1, r_2, ...r_n, r_{n+1}. Current arriving at f_n, from P, has two paths open to it to earth *via* R_n and r_{n+1}, hence the joint resistance from f_n is—

$$\frac{1}{\frac{1}{R_n}+\frac{1}{r_{n+1}}}$$

and from the point f_{n-1}, the resistance is—

$$r_n + \frac{1}{\frac{1}{R_n}+\frac{1}{r_{n+1}}}$$

The current arriving at the point f_{n+1} has, however, two paths open to it, one through the leak R_{n-1}, the

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other past f_n to earth. These paths are in parallel, and we have accordingly—

$$\frac{1}{\frac{1}{R_{n-1}} + \frac{1}{r_n + \frac{1}{\frac{1}{R_n} + \frac{1}{r_{n+1}}}}} \quad \ldots\ldots\ldots (4)$$

which written in the form of a continued fraction is—

$$r_1 + \frac{1}{R_1^{-1}} + \frac{1}{r_2} + \frac{1}{R_2^{-1}} + \ldots\ldots r_n + \frac{1}{R_n^{-1}} + \frac{1}{r_{n+1}}$$

UNDERGROUND HAULAGE BELLS AND TELEPHONES: TROUBLES AND THEIR REMEDIES.*

By J. S. KENDAL.

(*Continued from page 332.*)

In some cases annoyance is caused by the gongs becoming loose, some gongs being provided with a round hole and secured by a single nut which can easily be slackened by turning the gong. A square hole or a pin would obviate this trouble, and the gong standard should also be securely fixed to the base to prevent turning; a simple round standard riveted in is not of much use. Bell hammers also have a tendency to become loose after the repeated blows of sometimes only a week's use, with the result that they fail to strike the gong.

Points to be considered in the choice of pushes or keys are the strength of springs and contacts, clearance of terminals in case, and the freedom of operation when used by persons with muddy hands in wet places; it is found that some types are prevented from working by becoming choked with dirt as shown in Fig. 4. This latter trouble has in many cases been greatly reduced by the use of straight-ended plungers packed with vaseline. Anomalies in design will sometimes be found, such as keys with flame-tight lids and plungers but having plain bushed holes for wiring; telephones fitted with packing glands for wires and cords but having lids which are very rough and not tight in any sense.

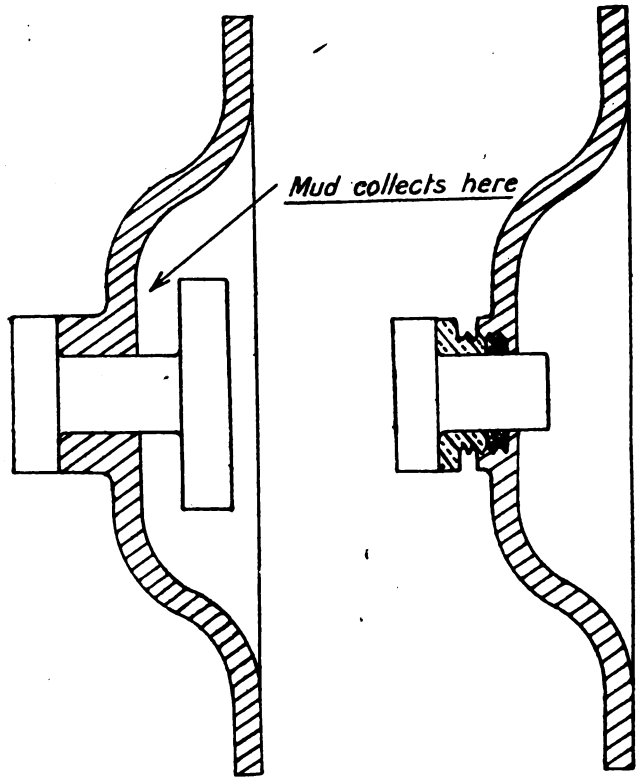


FIG. 4.

While referring to telephone design it is to be noted that here is abundant scope for improvement. It is particularly necessary to protest against the inaccessibility of almost all mining types; designers should consider that the majority of mining telephones are in almost continual use throughout the working day under conditions which are far from being ideal and that their adjustment is a vastly different proposition to that of surface instruments. More extended use might be made of a type which allows of the whole instrument being removed without interference with any external wiring or battery connections, connection to the instrument being made by means of a contact block and spring fingers.

The whole of the telephone parts should be standardised and interchangeable. Some makes will be found satisfactory in this respect, whilst with others, notably wood telephones in iron cases, although the component parts may be interchangeable, yet the complete instrument will only fit into its original case. This type of construction should be abandoned for mining work and an all-metal self-contained style adopted. With regard to the wooden instrument in a metal case, makers frequently overlook the fact that with a standard magneto telephone the spindle and driving handle of the magneto is alive, and that when placed in an iron case either the handle or the gland through which it passes should be insulated from the case, or otherwise the whole case becomes alive when a person is turning the handle. Unpleasant shocks are obtained and much trouble caused through inattention to this detail. Even where an insulated coupling is provided between the magneto and the handle it is often a source of trouble owing to weak mechanical construction. Receivers of the movable arm type are not much in evidence, their use in high seams might obviate trouble due to broken cords, but they are not suitable for low seams owing to the uncomfortable position which would have to be adopted by anyone using same. Where receiver cords are used the terminals and wires should be relieved of any weight and the cords should preferably leave the telephone case in a downward direction, because much trouble is experienced by cords being cut due to the use of a horizontal or side entrance gland.

Before leaving this subject, mention may be made of the inadequate fixing arrangements frequently found on apparatus of all kinds. For instance, one often meets with apparatus having ridiculously small cast-on lugs with small screw holes and insufficient metal to allow of such holes being enlarged for stronger screws. Even where strong fittings are provided the holes are often inconveniently placed; in one instance two holes for fixing an iron-clad bell are found in exact line with two other screws securing the cover, and it is hardly practicable to fix such a bell by ordinary screws except by driving them in a slanting direction.

Switches should be of substantial construction, with strong arms having ample contact surface and fitted with decent-sized terminals.

Having drawn attention to these defects, it is only fair to say that in some cases they have been attended to, although it is hardly possible to find any one piece of apparatus which is all that can be desired. In passing, it may be stated that the choice and use of a good type of apparatus will have a vast effect upon the satisfactory working of mining signals and will help greatly to smooth over difficulties met with in keeping underground traffic on the move and thereby preventing delays and loss of output.

With regard to the system of working haulage signals, requirements are so varied that it is almost impossible to keep to any one system throughout any colliery. The systems of haulage in use, modes of working at junctions,

*Paper read December 18, 1920, before the North of England Branch of the Association of Mining Electrical Engineers.

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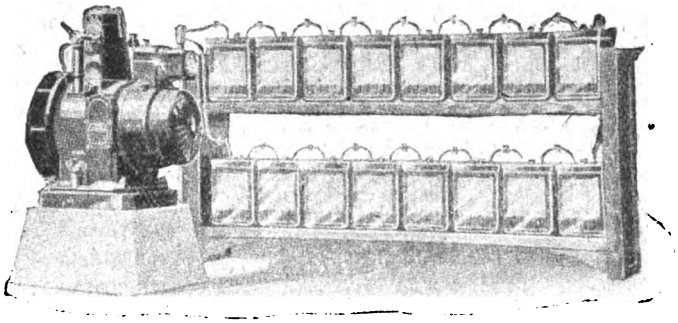
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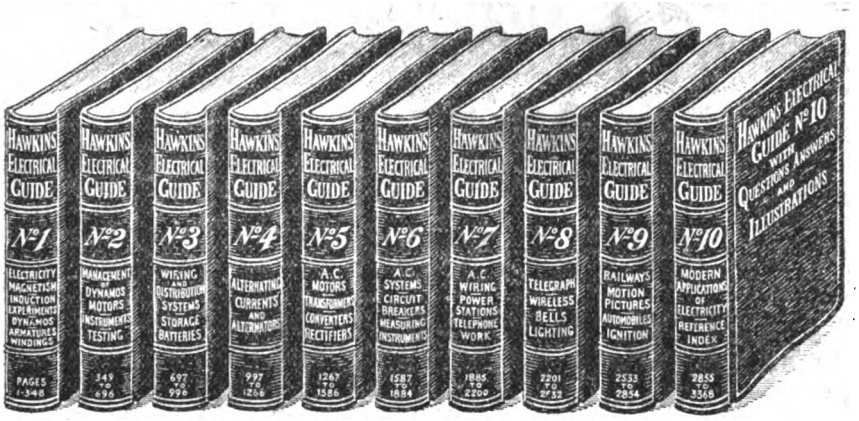
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changing of ropes, etc., have to be studied in planning any signal system. In fact no system of signalling can be specially mentioned to suit all conditions, but each case must be settled individually.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 119.

There were some fuse boards recently delivered to our works. The fuse clips are fixed to iron rods insulated with what appears to be mica or micanite. I would like to know how mica is placed round the iron rods in this manner, and what material I shall require to insulate the rods if a breakdown should occur.—"CLIP."

QUESTION NO. 120.

The distance between my house and a store is two miles. I wish to rig up a signalling apparatus between them so that I can be called up at the store if I am required at the house. I do not wish to go to the expense of fitting electric bells on account of the cost of wire and the inconvenience of running them. Can I use a system of wireless? If so, please can you give me some details that will assist me?—"COHERER."

(Replies to Questions Nos. 119 and 120 must be received not later than June 25, 1921.)

Personal.—Mr. L. W. Wild, M.I.E.E., Physicist to Automatic and Electric Furnaces, Ltd., sailed on the "Olympic" on the 15th inst. for New York, where, by arrangement with leading manufacturers, he will give practical demonstrations of Wild-Barfield Automatic Steel Hardening Furnaces.

Bruce Peebles and Co., Ltd.—Mr. Arthur T. Smith, A.M.I.E.E., of Albion House, Hanley, Stoke-on-Trent, has been appointed Agent for the Midland Counties of England. The Counties covered by the Agency are Stafford, Derby, Nottingham, Lincoln, Rutland, Leicester, Warwick, Worcester and Salop.

E. D. A. Economy in Postage.—The Director of the British Electrical Development Association desires to state that information and enquiries may, in future, be sent under same cover as circulars. Engineers, managers and others are requested to open and examine carefully all sample parcels of publicity matter and other communications from E.D.A. as received.

I. E. E. Conversazione.—The Deputation of American engineers now on a visit to this country for the purpose of expressing their appreciation of the work done by British Engineers in the War will be present at the I.E.E. Conversazione, to be held on Thursday, the 30th inst., at the Natural History Museum. About 10 p.m. Mr. Ambrose Swasey (Chairman of the Deputation) will speak in the Central Hall of the Museum, and he will be followed by Dr. F. B. Jewett (Vice-President Amer. Inst. E.E.), who will convey a message from the American Inst. of E.E. to our own Institution. The Deputation numbers 20 and includes Dr. A. E. Kennelly (Past-President Amer. Inst. E.E.) and Major-Gen. G. O. Squier, also representing the Amer. Inst. E.E.

SHIP ELECTRICAL EQUIPMENT REGULATIONS.

The rules relating to the above recently issued by the I.E.E. have done much towards the standardisation of electrical installations on ships—they have been adopted, with certain omissions, by Lloyd's Registry of Shipping and are now in force for all ships built under their survey throughout the world. Moreover, very few questions, indeed, have arisen in connection with them. However, according to the May-June issue of the *Channel*, there appears to be a field for careful investigation by the I.E.E., in consultation with owners and builders, of reducing to a minimum the types of cables to be used and the methods of fixing them. This appears to be a reform of much importance, as it would enable shipbuilders to carry reasonable stocks of the standard cables agreed upon.

Although the cables must withstand moist salt air, high temperatures encountered in engine and boiler rooms, low temperatures experienced in cold chambers, mechanical injury possible in holds, crew's quarters, etc., and sea and rain water in exposed positions, an examination of vessels of different companies, or a perusal of their specifications, will show clearly that, to meet any one of these general conditions, cables differing widely in composition are adopted and various methods applied to their erection. Taking the engine room as a particular example, says our contemporary, we find V.I.R. cables run in wood casing, in galvanised conduit, or on porcelain cleats; L.C. (lead covered) cables attached by brass clips to the ship's structure or separated from the ironwork by wooden grounds, or fixed to perforated metal trays; L.C. and A. (lead covered and armoured) cables clipped to ironwork, wood grounds or metal trays; V.I.R armoured cables (without lead sheathing) or "Cab-tyre" sheathed cables fixed in similar ways; and still another alternative—bare copper run on insulators contained in sheet-iron casing. This latter has been applied only to mains between dynamos and switchboards, we understand, and clearly would not be suitable for general wiring. Types of cables are numerous, viz., V.I.R.; plain L.C.; L.C. with braided asbestos covering; L.C. jute served and galvanised steel wire armoured; the same without jute serving; L.C. jute served, armoured and braided overall; the same without jute serving; V.I.R. with cab-tyre rubber sheathing; and the same but braided outside.

Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

ELECTRICITY AT HIGH PRESSURES AND FREQUENCIES. By Henry L. Transtrom. 248 pp., 141 figs. (Joseph G. Branch Publishing Co., Chicago. Sec. Edin., Paper, 12s. 6d., cloth 15s.).—Under half of the book is devoted to that section of electrical science embraced by the title, the greater part being in the nature of a discourse on the elementary principles of magnetism and electricity, and their practical application in certain instances. An attempt has been made to treat the subject in a simple manner, the aid of hydraulic analogies being invoked in several instances in this connection. Such treatment is not scientific in all details, but, as given, is as accurate as the elementary conceptions presented, *i.e.*, there are numerous small errors throughout. When the consideration of high-pressure and high-frequency electricity begins we find that the author is aiming at a description of the spectacular, and, later, particulars are given of apparatus to produce, and experiments to show, "fireworks." Altogether it may be said that the book has no practical value, but in parts is interesting and occasionally instructive.

Credenda Conduits Co., Ltd. (Aston, Birmingham), are now handling Credenda Cables and flexibles. Full stocks of Creda and Credenda lines are held at the Company's new Glasgow branch.

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Various Items.

Rotherham.—We learn from the *Sheffield Independent* that the Prince of Wales will open the new generating station on July 20.

Melbourne.—The Metropolitan-Vickers Electrical Co., Ltd., has secured a contract for five 12,500 kw. three-phase 50 cycle 6,600 volt. turbo-alternators, to be installed in the Morwell power-house.

Electrically-driven British Warship.—The Admiralty is considering electric propulsion as an experiment in one of four new £9,000,000 battleships, the plans for which are now being decided.

Removal.—Messrs. Archibald J. Wright, Ltd., Manufacturing Electricians, have removed (from 61, Eden Grove, Holloway) to new premises at 395, City Road, London, E.C.1, to which address all future communications should be sent. Telephone No.: City 7013.

Royal Society of Arts.—The Albert Medal of the Society for 1921 has been awarded to Professor John Ambrose Fleming, M.A., D.Sc., F.R.S., in recognition of his many valuable contributions to electrical science and its applications, and specially of his original invention of the thermionic valve, now so largely employed in wireless telegraphy, and for other purposes.

South Manchuria Rly. Co.—The total estimated expenditure on works during 1921-22 is Yen 55,960,827, including 2,485,961 on electrical works. The latter includes the establishment of an experimental station at Dairen, erection of a second power station at Dairen, a third at Antung, and extensions to the Dairen electric tramways.

Metric System Adopted by Japan.—A new Weight and Measure Law has just been promulgated by the Japanese Govt. According to the Yokohama Chamber of Commerce *Journal*, within the five years beginning with the date from which the Law takes effect all public works, Govt. offices, schools and large factories will be made to adopt the new system, while the general public will be given 20 years' grace.

Peat Fuel.—Further attempts are being made in various parts of Ireland to turn to better use the enormous tracts of peat which are practically undeveloped. The very dry weather has enabled the peat cutters to get a larger and earlier supply and the peats are being used in many industries to supplement the small proportion of coal. Some of the light railways are using peat fuel.

Arc Lamps.—In view of the fact that there are still many thousands of arc lamps in use in installations throughout the United Kingdom, as well as in the Colonies, we would recommend readers who are interested in the care and maintenance of such lamps to make a point of reading Mr. Eck's well-known book, "Application of Arc Lamps to Practical Purposes," price 2/9, post free from this office. It is looked on as the most practical and useful book on this subject which is now on the market and can be recommended to all who are interested in the subject.

Inst.C.E. Engineering Conference.—On Tuesday, 28th inst., at 9 p.m., Sir Geo. T. Beilby, F.R.S., will deliver the 27th James Forrest Lecture, on "Fuel Problems of the Future," and on the following day the President will open the Engineering Conference, welcoming the delegates from the American Engineering Societies. The programme includes a number of visits to works and other engineering establishments, and several meetings at which various subjects will be discussed. Among the works to be visited are Siemens Bros., Charlton Works; Vickers, Ltd., Erith Works; Fraser & Chalmers, Erith Works. The subjects for discussion include: Low Power Factor, opened by R. O. Kapp; Battery Locomotives, by J. Dalziel; the Mechanical Advantages of Electric Locomotives compared with Steam; Steam v. Electric Winding, by W. C. Mountain; Low Voltage Overhead Distribution, by B. Welbourn; and Economic Limits of Distribution from Coal-fired Stations.



Disabled.—A reader of this paper, an invalid ex-officer, is interested in electrical science and would be very much obliged if any readers can send old trade catalogues for him to glance through. They should be sent c.o. Mrs. Steggal, Baughurst Rectory, Basingstoke.

Service Notes.—Further ex-officers have been posted to the Defence Force in connection with electric light companies and motor companies. Warrant Telegraphist R. W. Craig has been posted to the "Vulcan," depot ships for submarines at Chatham, from the 25th inst. Warrant Electrician P. J. Freeman has been appointed to the "Vernon," torpedo school ship at Portsmouth, from the 4th inst. Recruiting for the various electrical departments of the Navy and Army is doing very well at the moment, the state of the labour market being favourable to enlistments, as well as the generally better conditions of service and better pay in both the Navy and Army.

Belfast.—A breakdown in the electricity supply for over two hours occurred shortly before midnight on Sunday, the 5th inst., due to a breakdown in the positive main, situated near the city centre. Concurrently, an attempt was made to isolate Belfast by cutting the telegraph and telephone wires at various points, so that the failure of the electric current in all probability was due to the action of the Sinn Feiners. Quite recently, a Belfast Post Office electrician was sent to gaol to meditate for a year or so on the errors of his ways. He was employed as a linesman in the day time, and spent part of his nights in going with other Sinn Feiners to cut the wires outside the city. Naturally in the mornings he had no great difficulty in locating where the wires had been cut. Unfortunately for himself, he and his colleagues were spotted by a couple of the Ulster Special Police, who at the point of their revolvers herded the gang into the local police barracks.

Trade Notes.

The **"Z" Electric Lamp & Supplies Co., Ltd.** (73, Newman Street, London, W.1), have decided to increase the discount to the trade off the recently reduced price of the "Electrolux" Cleaner.

We have received from **Automatic & Electric Furnaces, Ltd.** (281-3, Gray's Inn Road, W.C.1), "Heat Treatment Bulletin," No. 28, dealing with the heat treatment of carbon tool steel, by Lancelot M. Wild.

"Ecal" hacksaw blades are listed in a leaflet received from **Engineering & Colliery Appliances, Ltd.** (Sheffield). "Ecal" blades are made throughout at the Sheffield factory, and possess great flexibility, combined with excellent cutting properties.

Hart Accumulator Co., Ltd. (Stratford, E. 15), are offering 4-volt 3-plate "A.B.S." type "Hart" ignition batteries in celluloid boxes (5 amp.-hour capacity) at specially favourable prices. In a leaflet just received, these are advocated for small electric motors on model and toy work, etc. The size is 1⅞ in. by 1⅞ in. by 4¼ in., and the weight 17 oz.

A 24 pp. catalogue of Ediswan electric fans to meet all requirements has just been issued by the **Edison Swan Electric Co.** (Ponders End, Middx.). To assist dealers further in the sales of Ediswan fans, the Co. has produced a two-colour window-bill and an attractive little folder containing illustrations and particulars of table, convertible, table-bracket, etc., fans for domestic use. These folders are for overprinting. In addition, besides general fan advertising in technical and trade papers, a coloured showcard is exhibited in the electric trains of the Met., Hammersmith-City, G. N. & City, and Mersey Rlys.

The construction of the "Kingsway II." miners' electric hand lamp is dealt with in considerable detail in a new list produced by the **General Electric Co., Ltd.** (Magnet House, Kingsway, W.C.2). The lamp is approved by H.M. Home Office, and is already in considerable use in mines. It is round, has a china lampholder and switchplate in one piece, magnetic lock and accumulator, designed on the principle of the non-spillable inkwell. If laid on its side, the acid does not cover the gas vent-hole, which also has a conical end to deflect splash. Escape of acid is effectively prevented. Spare parts are illustrated and priced separately, while charging racks, standing racks, opening magnets, Osram miners' hand lamp, pattern bulbs and all accessories are described, illustrated and priced.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
PRACTICAL TRADE JOURNAL
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THE LONDON ELECTRICITY PROBLEM.

(*Continued from page* 346.)

The inquiry which is being held by the Electricity Commissioners into London's electricity supply has been continued daily, with the exception of Monday, since our last issue. Mr. J. H. Rider, engineer, representing the London County Council, gave evidence for 2½ days concerning the engineering details, which have been worked out in conjunction with Sir Alexander Kennedy and Mr. G. W. Partridge, representing the nine companies who are promoting a rival scheme, and Mr. C. H. Wordingham, representing the Conference of Local Authorities owning electricity works, which is also promoting a scheme. We have been given to understand that all these parties are agreed on the engineering side, but for the full extent of this agreement we shall have to wait for the presentation of the other schemes.

Mr. Rider's evidence has made it clear that an important change has been made in the proposals originally placed before the Commissioners by the London County Council. In March, a complete administrative, technical and financial scheme was presented on the assumption that new main generating stations would be put in hand immediately the Joint Electricity Authority, proposed in the administrative portion of the scheme, was elected. Subsequent consideration, however, has led to a complete change of plan. Instead of proceeding with the erection of the four proposed generating stations at Chiswick, Greenwich, Beckton, and on the site of the old Thames Ironworks, it has been found that, owing to the high cost of plant, the advantage to be derived from generation on a large scale will be more than counter-balanced by the extra capital charges involved. Hence the decision has been come to by the L.C.C.'s advisers that it will be more economical, in that it will at least obviate expenditure of a large sum of money now, to link up a certain number of existing stations, to scrap certain plant in them and proceed with extensions already authorised. That will form what is called the first stage and would give, say in 1925, a plant capacity of 557,000 kw. If, by that year, the demand has grown beyond that figure or shows signs of doing so during the first stage, two alternatives are put forward, either to install further plant in certain selected stations, numbering nine or ten, or prepare for the erection of capital stations. This plan of action leaves out of account any question of helping, at any rate for some years, a good many of the districts on the outer fringe of the area delineated by the Commissioners, a fact which has not been lost sight of by such of those authorities as desire to be left out of the scheme altogether. It is estimated as possible to increase the capacity of the existing stations to 760,000 kw. before the need for erecting new large power stations arises, and it may be mentioned that a demand of 480,000 kw. is contemplated by 1925.

Questions were put by Mr. Booth, one of the Commissioners, to the effect that as the outer areas were not to be benefited for some years, the question arose as to leaving them in at all.

The general answer to this and other questions by cross-examining counsel on the point, was that an area must be taken, and that the whole underlying principle of the unification of control would be defeated if certain portions were cut out.

Again, the railway companies have expressed their determination not to take supply from the Joint Electricity Board—which, if appointed, will take over the whole of the generation throughout the area—but will erect their own generating stations, on the contention that they will be able to generate more cheaply than the Joint Electricity Board can. The L.C.C. estimates have left out of account, during the first stage, the railway load, and Mr. Rider seems to have adopted the railway companies' assumption of being able to supply themselves more cheaply, as he told the Commissioners quite frankly that this was so for the reason that the Joint Electricity Board would have to meet sinking fund charges on its undertaking, whereas the railway companies would not.

During the Commissioners' cross-examination of Mr. Rider, it was made apparent that this view did not altogether appeal to them. In the first place the fact that the railway companies would have generating stations not under the control of the Joint Board was regarded by Mr. Page as a weakness, in that it would prevent that complete control of generation which the original scheme of the L.C.C. laid down as essential. On the other hand, Sir John Snell, the Chairman of the Commissioners, was not at all disposed to accept, without further details, the facts that the railway companies could generate, by reason of the lack of sinking fund repayments, more cheaply than the Joint Authority. However, under the Electricity Act of 1919, the Electricity Commissioners are bound to grant permission for the erection of new power houses, unless it can be shown that an abundant supply can be obtained equally cheaply from other sources. Thus, the last word rests with the Commissioners. Sir John Snell pointed out that one of the reasons which weighed with the Commissioners in delimiting, provisionally, the area they have, was that the "fringe" areas would be assisted from the railway supply.

According to the new scheme now placed before the Commissioners, the estimated cost of generation over the whole area per unit, delivered to feeders by authorised distributors, after conversion, is 1.385d., and for the first stage of the linking up scheme, compared with 1.488d. per unit if the original scheme of building capital power stations at once was proceeded with, assuming in both cases no railway load. The original scheme, adding 200,000 kw. railway load, is estimated to provide current at 1.377d., and it is because of the slight difference between the cost of current by the main scheme and by linking up, that it was proposed to postpone the expenditure of a large sum on new power stations as long as possible. When eventually the four capital stations are built, and the Deptford and Stepney stations are extended into main generating stations as contemplated, there will only remain in operation, of the existing power stations, Willesden (North Metropolitan Power Co.), St. Marylebone; Grove Road (Central Electric Supply Co.), Hackney; Bow (Charing Cross Co.), and Bankside (City Co.). That condition of things, however, will not be reached for several years.

So far as the administrative part of the scheme goes, that remains as originally placed before the Commissioners. A Joint Electricity Authority will be formed, with proportionate representation as mentioned in our last issue, which will take over the whole of the generation. All stations will be acquired in some form and, until eventually shut down,

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might be worked by the existing distributing authorities. The whole of the revenue, however, would be to the credit of the Joint Authority, and even the book-keping would be managed by it.

The capital stations, when built, are intended to have a capacity of 200,000 kilowatts, the supply being 3-phase, 50-cycles on the north side, and both 25 cycles and 50 cycles on the south side of the river. The main transmission would be at 33,000 volts, and the secondary transmission 6,600 volts. The final details, however, can hardly be settled now; much will depend upon the exact technical position when the work is put in hand. As a matter of fact, very little attention is being paid to the technical details either of the new stations or even of the proposed linking up.

Chief opposition to the L.C.C. may be said to come from those who wish to be cut out of the scheme. The conference of Local Authorities owning electricity works and the nine companies who have deposited alternative schemes, have much in common with the L.C.C. scheme, and have not yet seriously pulled it to pieces. Much more severe criticism has come from the Middlesex and Hertfordshire County Councils—who mainly fear an extension of the London County boundaries into their areas—and the North Metropolitan Electric Power Co., and the Metropolitan Electric Supply Co., who desire their power supply areas cut out. Then there is the County of London Co.—which already has a scheme for a large power station at Barking before the Commissioners—and the railway companies, and a host of small authorities who do not wish to be saddled with a share of the administrative expenses of the Joint Authority, at least until they are likely to come into the scheme. There is a great fear on the part of the local authorities that the Joint Electricity Authority will develop into another Metropolitan Water Board.

One interesting technical point worth mentioning is that one of the proposed power stations is to be erected in proximity to the Gas Light and Coke Co., at Beckton, and from a remark made by Mr. Rider is intended to be worked in conjunction with it.

The result of four days' hearing was that the case for the L.C.C. scheme had not been completed. With the opposition yet to be heard, and five other schemes to be considered, it can safely be prophesied that the inquiry will be a long one.

The case for the London County Council's proposals was concluded on Tuesday, June 21, and the consideration of the proposal which has been put forward by the Conference of Local Authorities Owning Electricity Works in the area scheduled was proceeded with.

The conference represents all the local authorities owning electricity works, with the exception of Poplar, which has its own scheme, Reigate, Epsom, and Watford, and Watford and Reigate both wished to be excluded from the L.C.C. scheme. On the engineering side, of course, as already indicated, the L.C.C. scheme is practically agreed, and the main points of difference are in relation to the administrative side. For instance, under the Local Authorities' scheme, the constitution of the Joint Electricity Authority is quite different. Acting upon what is believed to be the true construction of Section 6 of the Electricity Act of 1919, which states that the Joint Electricity Authority shall be representative of the authorised distributors, it is proposed that there should be 29 members, of which 12 would be representative of the local authorities owning electricity works, 12 representative of the companies—but of this latter 12, 8 are to represent the purchasers—3 shall represent large consumers and labour, and then there are to be the chairman and vice-chairman. The principal point of difference in the working of the Joint Authority is that there will not be that complete control as proposed by the L.C.C. In the latter case the Joint Authority will decided finally how the stations are to be worked and generally will manage the generating side of the business, but the Local Authorities' scheme recommends that there should be an appeal to the Electricity Commissioners.

In connection with this point, the Commissioners put some questions indicating that they would not be in favour of any scheme which did not provide for some definite control. Sir John Snell suggested that if all the Authorities represented on the Conference were agreed on the engineering details it did not seem to matter that the Joint Authority should have complete and absolute control of the generating side.

It was also argued, for the Local Authorities, that Clause 14 of the London County Council's scheme is ultra vires in that it compels undertakers to transfer their generating stations, whilst Section 9 of the Electricity Supply Act of 1919 states that any transfer must be with the consent of the authorised distributor. It was stated that the Local Authorities, in drawing up their scheme, felt in some difficulty as to how far control should go, not from the technical but from the legal point of view. If the authorities agreed, then there would be no difficulty at all.

Sir John Snell said that he was voicing the views of the Commissioners when he stated that no scheme would satisfy them which did not give a definite promise of something being done in the future.

(To be continued.)

THE RELAY AUTOMATIC TELEPHONE SYSTEM.

FOR PUBLIC AND PRIVATE EXCHANGES.

A little while ago, Mr. H. D. Dipple read a paper on "The Relay System of Automatic Switching" before the Inst. of P.O. Electrical Engineers, and at the same time the Relay Automatic Telephone Co., Ltd., of Marconi House, Strand, W.C.2, showed in operation a small demonstration board for instructional purposes for the India Office. A number of installations of the Relay Automatic Telephone System have been erected in different parts of the world—besides India, where the system will be largely in use, a public exchange is being erected at Fleetwood for the British P.O. In this case, the manual operators who will deal with long-distance connections and enquiries will be located at Blackpool. The following is a list of improvements made in the system since it was first described:

(1) Substitution of Post Office standard telephones and dial form of calling device with loop working, instead of telephones with levers and earth working.
(2) Relay made up of unit parts.
(3) Subscribers' distribution of both originating and inward calls, and three digit (1,000 line) final stage.
(4) Auxiliary P.B.X. line working for numbers not necessarily consecutive, and groups of any size.
(5) Distribution fields for varying the number of trunks in accordance with the traffic.
(6) Recorders not taken into engagement with calling line until the caller commences to dial.
(7) Multi-exchange working over two wire junctions.
(8) Two wire working to Manual exchanges, with the manual operator controlling the line and receiving standard supervision, busy-back tone and flash, and number unobtainable tone and flash from the automatic exchange.
(9) Subscribers' metering at the termination of the call.
(10) Traffic metering circuits enabling a continuous record of the number of calls dealt with or lost in each section of the system are provided.
(11) A thermostat for releasing common apparatus from faulty lines also provides for a delayed release.
(12) Subscriber's fault relay which prevents faulty lines from re-engaging common apparatus after being released by the thermostat.
(13) Searchers for groups of 100 lines dispensed with and each group of 10 lines provided with its own searching means.
(14) Ringing cut-off immediately called subscriber answers.

A simple exposition of the system has now been provided by the company in the form of an illustrated booklet dealing

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with the use of the system for private telephone installations in factories and business premises. Naturally, the system is "secret," and can be readily extended. As its name implies, relays only are required on the exchange. There are no electro-mechanical switches of any kind. These relays measure only 4 in. by 1¾ in. overall.

COLOUR EFFECTS IN STAGE LIGHTING.

A new and efficient system of stage lighting has been designed by the British Thomson-Houston Co., Ltd. Each unit of the equipment comprises an X-ray mirror reflector, a Mazda gasfilled lamp and a metal framework to hold colour gelatine glass. The required number of units is assembled in a metal trough, and the equipment is supplied in four different patterns, viz., concentrating battens, distributing battens (Fig. 1), floats (Fig. 2), and proscenium strips. The concentrating battens are intended for the intense illumination of particular sections of the stage. They are equipped with "Jupiter" X-ray reflectors and with either 100 or 200-watt Mazda gasfilled lamps. Using 100-watt lamps, this form of batten gives a downward illumination of 1,000 c.p. per lamp. That is, a batten containing thirty 100-watt lamps would project a light of 30,000 c.p. on to the stage. For the general illumination of the stage, distribution battens, equipped with "Scoop" X-ray reflectors and 100 or 60-watt Mazda gasfilled lamps are recommended. Special "E.60" X-ray reflectors and 60-watt gasfilled lamps are used in the float and proscenium strip.

It is obvious that the efficiency of this quipment is vastly

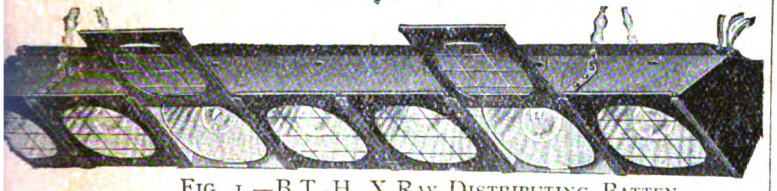


FIG. 1.—B.T.-H. X-RAY DISTRIBUTING BATTEN.

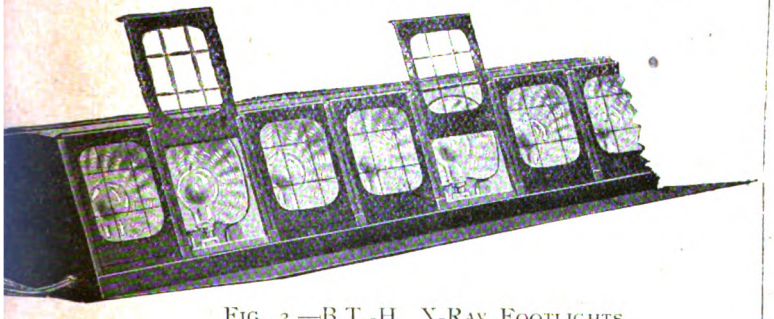


FIG. 2.—B.T.-H. X-RAY FOOTLIGHTS.

higher than that of the apparatus ordinarily used, as the X-ray mirror reflector reflects a much greater proportion of the light than the painted troughs hitherto employed, and gasfilled lamps cannot be used in the equipment generally met with. In many cases the installation of B.T.-H. equipment may be expected to bring about increases in overall efficiency up to 200 per cent. Further, as it is not necessary for the lamps themselves to be coloured, there is no risk of breakage from handling to effect this.

Over the mouth of each reflector is fitted a sliding frame, into which the colour gelantine is slipped, so that with a fair supply of gelatine slides of various tints a producer can get any colour effect desired, and can change from one effect to another in a few seconds by the substitution of one set of slides for another. In order to change effects with coloured lamps, he must either keep a large reserve of lamps already tinted, or have the lamps at present in use cleaned and re-dipped. In either case the process is lengthy, expensive and inconvenient to a degree which seriously limits the producer in his search for appropriate colour effects. With the system under consideration, however, he is able to experiment with various combinations of colours and to change from one to another almost instantaneously and entirely without expense.

The system has already been installed in two of the leading London theatres and the equipment for several other theatres is now being made. Further information on the subject may be obtained from the Illuminating Engineers' Department, The British Thomson-Houston Co., Ltd., 77, Upper Thames Street, E.C.4. We understand, by-the-way that this company is busy with the manufacture of other stage-lighting appliances which are likely to cause a considerable stir in the theatrical world. Although these appliances are not yet sufficiently advanced to be publicly described, interested inquirers will no doubt be informed as to the scope and general application.

AN INDUSTRIAL OPTIMIST.

In the current (June) issue of the *Industrial League Journal*, Mr. H. G. Williams, who has been fairly accurate in his prophesies so far, writes:—

"The world-wide indications at the moment show the beginning of a general revival of commercial confidence. A world revival in trade may be predicted with considerable certainty, and this country will share in that revival provided that British goods can be offered at prices sufficiently attractive.

"This will probably involve employers and employed making adjustments in their minds as to the money value of the profits and wages which they can reasonably expect to obtain, but even more important is the increase in individual production which will ensure lower selling prices without the necessity of any serious lowering of the standard of living, though, temporarily, both employers and employed may find themselves forced to accept a lower standard than they have enjoyed in the recent past."

Mr. Williams has also contended that the cost of living by the close of the summer will have fallen to double pre-war, and that it will not be long before it is further reduced to 75 per cent. above the pre-war cost.

WOMEN AND ELECTRICITY.*

(Lifted from a source that has been forgotten.)

When a woman is sulky and will not speak	Exciter.
If she gets too excited — — —	Controller.
If she talks too long — — — —	Interruptor.
If her way of thinking is not yours —	Converter.
If she is willing to come half way —	Meter.
If she will come all the way —	Receiver.
If she wants to go further — —	Conductor.
If she wants to go still further —	Dispatcher.
If she wants to be an angel — —	Transformer.
If you think she is unfaithful —	Detector.
If she is found to be unfaithful —	Lever.
If she proves your fears are wrong —	Compensator.
If she wants chocolates — —	Feeder.
If she sings wrong — — — —	Tuner.
If she is a poor cook — — — —	Discharger.
If she is wrong — — — —	Rectifier.
If she is cold to you — — — —	Heater.
If she gossips too much — — —	Regulator.
If she becomes upset — — — —	Reverser.

*Taken from the *Henley Telegraph* (Staff Magazine).

Meetings.—A general meeting of the Inst. of Production Engineers will be held at the Inst. of Mechanical Engineers, Storey's Gate, S.W.1, on Friday, July 15, at 7.30 p.m., when all who are interested in matters appertaining to production are invited to attend. At this meeting, Mr. Max R. Lawrence, M.I.M.E., M.I.A.E., will deliver a paper on "Production and the Engineer"; the proposed activities of the Institution during the coming winter session will be outlined, and announcements will be made with regard to the election of various gradee of members.

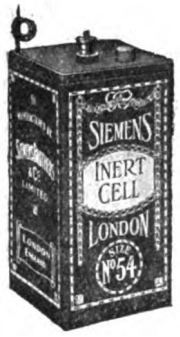
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PRIMARY CELLS AND BATTERIES.

Large users of primary cells and batteries will be pleased with catalogue No. 600, just issued by that old-established firm of manufacturers of this class of electrical material—Siemen Bros. and Co., Ltd., of Woolwich and Caxton House, Westminster. It is the post-war edition of their main catalogue of primary cells and batteries and runs to 88 pp., giving the most complete particulars of the principal dry and fluid cells. It is greatly enlarged and more comprehensive than the pre-war edition and is a most useful and informative guide, embodying the results of over 50 years' specialised and unrelaxed attention by the technical staff at Woolwich. Besides full information about the many dry cells particulars are given of the Siemens "Inert" Cells, which may be stored in the condition in which they leave the Company's Woolwich works for an indefinite period in any climate without deterioration taking place. The addition of water alone renders them active. Naturally



SIEMENS NON-INCRUSTING ZINC.



"INERT" CELL.



DRY CELL.

Leclanche cells of all kinds figure largely, and among the many zincs is to be found the Siemens taper non-incrusting type. The ordinary cylindrical zinc rod becomes consumed more quickly at the surface of the exciting solution than at any other part—it may even be completely eaten away at this point, when a considerable proportion of the zinc will fall to the bottom of the cell and become useless. The Company's improved zincs are of such shape as to compensate for this irregular consumption, and it is found that, under normal conditions, practically the whole of the metal is consumed usefully. This zinc is suspended from the containing vessel of the cell by a hook and in the agglomerate form of cell this attachment permits the use of plain india-rubber bands instead of the more expensive loop form. It should also be noted that as mercury is incorporated in the zinc throughout, and not merely on the surface, the zinc is virtually free from local action. It can easily be cleaned, but should be handled with reasonable care, as an element of brittleness is introduced by the presence of the mercury.

Other cells dealt with include varieties of Daniell, Bunsen and Bichromate. The catalogue is embellished with handsome coloured illustrations of the chief types.

Two other catalogues, viz., No. 531A, Leclanche Fluid Cells and Batteries, and No. 537, Dry Cells and Batteries, are made up to some extent of excerpts from the principal catalogue to suit less pretentious needs. A fourth catalogue, No. 531 B, entitled "Electric Cells and Batteries: Fluid and Dry," has been prepared with a view to meeting the needs of those dealers in and users of cells who are less widely acquainted with the technical side of the subject and are interested mainly in the more generally employed types.

BARE COPPER BARS IN PLACE OF INSULATED CABLES.

In early electrical installations bare copper conductors were often used between generators and switchboards and in various parts of consumers' installations; there was even one method of distribution which employed bare distributing mains carried on suitable insulators in a covered trench or conduit. It now appears likely that bare conductors will again be used to a large extent, but for different reasons, and, owing to the improved materials and methods, with greater safety and success than attended the early installations.

Writing in *The Central Station*, H. S. Wynkoop states that there is a growing tendency to use bare copper busbars instead of insulated cables where heavy current has to be carried, and that this system is employed in a number of large office buildings and in kinematograph studios. If the required conductor section exceeds 500,000 circ. mils., an insulated cable is unwieldy, and where some thousands or even tens of thousands of amperes have to be handled, cables must be used in multiple. Under such conditions it is difficult to accommodate and support cables and conduits. Also the switchboard and panel lay-out are cumbersome and expensive where cables are used in multiple.

In the famous Equitable Building bare rectangular busbars lead from the switchboard along the ceiling of the engine room to the riser points, these bars being guarded by a heavy metal grille. In later installations bare bars have been used also for feeders and mains.

The bare copper can be worked at 50 per cent. higher current density than is permissible in insulated conductors, and a heavy overload causes no damage to porcelain insulators. The cost of insulating covering and of conduit is avoided and the saving so effected is greater than the cost of the supporting bracket, porcelain insulators and metal grille, particularly when allowance is made for the fact that the bare conductor installation is practically everlasting. The copper and porcelain require no maintenance, and the iron brackets and grille require only occasional painting or galvanising.

Where bare conductors are used, each leg of the circuit is composed of a single conductor (which can, of course, be laminated to reduce eddy current losses and to increase the cooling surface), and due to the elimination of multiple circuits the switchboard is much simplified and cheapened. Arrangements can easily be made so that additional copper bars can be added on the same support when it is required to increase the current-carrying capacity. Excellent insulation is obtained and the whole of the line can be inspected readily at any time.

Hand in hand with the bare riser, says the writer (who is in charge of electrical inspection in New York), go the unbroken neutral and the single-pole branch circuit knife-blade switch. Later this will lead (in American practice) to single-pole fusing of the branch circuit and thus to a further simplification of the panel. Taken together, these developments represent important economies in the wiring of large installations.

THE PED-O-SCOPE.

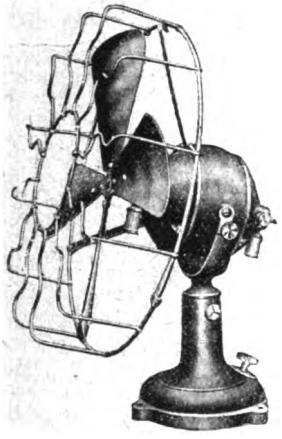
A novel device, called the Ped-o-Scope, with both a utility and an advertising value for retail boot and shoe establishments, has found its way into this country from the U.S.A. The device, which is made by X-Rays, Ltd., of 11, Torrington Place, Gower Street, W.C.1, is a simple X-ray contrivance in an elaborate wooden fitment, designed so that when a customer tries on a boot or shoe the bones of the foot are clearly seen together with an outline of the sole and general shape of the shoe. In fact, in twenty seconds or less it can be determined whether the shoe is a perfect fit or not, provision being made for two people, besides the customer, to view the fit. The running costs are very low, but, of course, the first cost is somewhat high.

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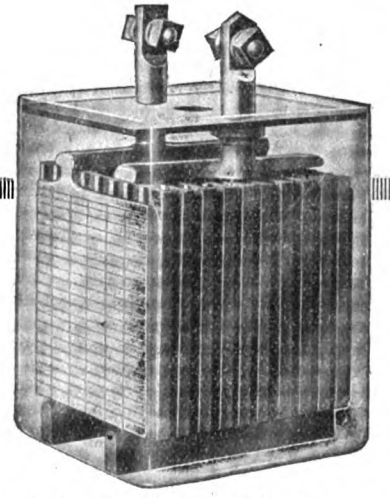
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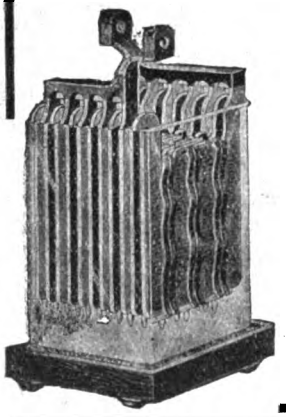
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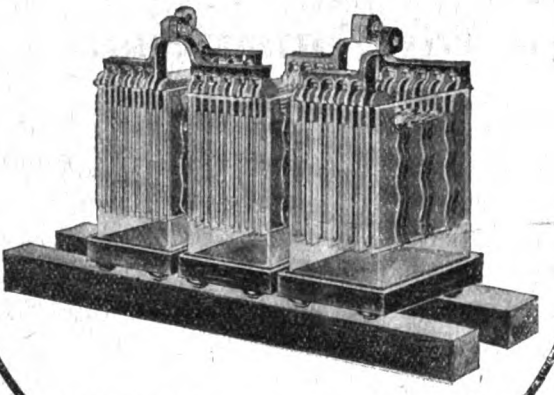
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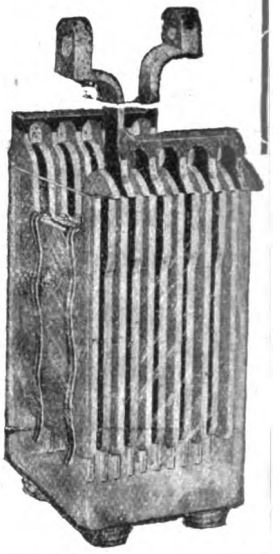
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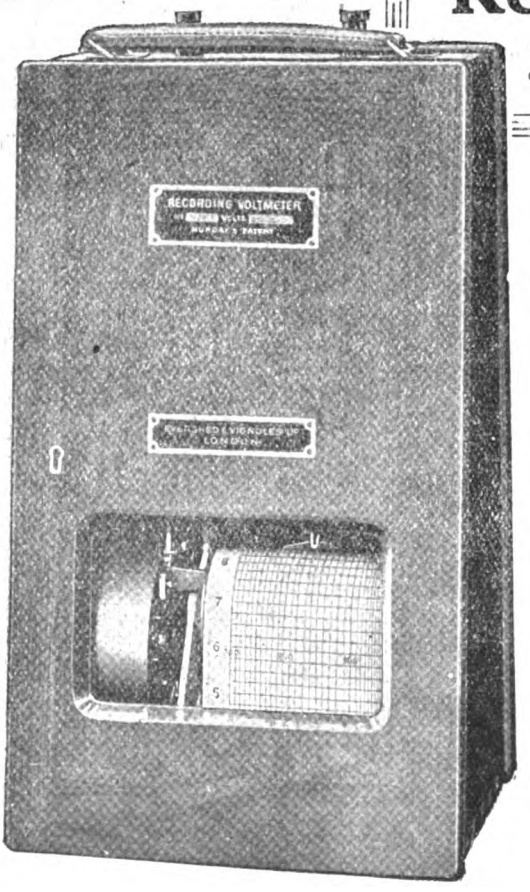
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ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning,** in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

The "Disagreeables" of Industry.

A fair proportion of the discontent always existent in industry, to a greater or lesser degree, is doubtless attributable to what may be termed its "disagreeables," among which dirt, noise and smell figure largely. Modern improvements and methods have considerably mitigated the unpleasantness of many occupations, but there is still a good deal of reformation needed in certain industries which would render them far pleasanter to those who spend the best hours of their lives and earn their daily bread in factories and workshops. Such drawbacks as I have referred to above are those which offend the natural senses—not consciously, perhaps, but subconsciously—reacting on the human temperament, thus conducing to a state of irritation in which the individual worker is readily affected by other minor matters which, in his natural state, he would disregard altogether as trivial and beneath notice.

My remarks are prompted by an interesting article in *Engineering*, under the title "The Cinderella of the Engineering Industry," the writer of which refers to the foundry as the most neglected department of an average engineering works. Moulding has almost been regarded as the Cinderella of the trades, to be carried on by grimy men in a dark and dirty building, suitable for no other purpose. Even though the reputation of many an engineering concern is largely attributable to the excellence of its castings, the moulder rarely receives either the credit or the consideration which his skill deserves. The reason is not far to seek. Like smithing, also a dirty trade, moulding is one of the fundamental processes, the finished product of which is the raw material for other departments of industry, so that when a casting commences its useful life it is merely part of a machine, and has lost its identity by becoming a portion of some more elaborate mechanism.

Another reason, and to my mind the main one, why moulding fails to receive its proper share of attention lies in the nature of the trade. It is necessarily more dirty and less pleasant than most of the other engineering trades, and is thus unattractive to the class of youths from whom professional engineers are mostly drawn. It is only the ambitious and conscientious youth whose interest survives his experience in the foundry of a big engineering works. A favourite nephew of mine, who lost his life in a nose dive during the war, had just passed through the foundry of a large engineering works before joining the R.A.F., and I well remember his enthusiasm on the subject of foundry work, in which he quite lost sight of the associated dirt and discomfort when working therein.

There are similar disabilities attaching to most engineering processes, dirt and noise being inseparable from many of the branches of this great industry; but there is room for considerable improvement even in those departments such as the foundry, smithy and fitting shops, where oil, grease and dirt are generally regarded as inseparable from the operations conducted therein. Dirt has been rather aptly defined as matter in the wrong place, and, taking this simple axiom as the basis of our crusade for the betterment of industrial environment, quite a lot could be accomplished towards making the ordinary engineering processes much cleaner and more attractive to the individual worker.

There is no real reason why a foundry, for instance, should be a dirty, gloomy building, with a floor reminiscent of a corporation dust-tip. The essential sand could, by judicious organisation, be confined to its proper areas; the windows can be kept clean, permitting the entry of an average quantity of daylight, and, after dark, the illumination need not necessarily be of a limited character, or depreciated by the existence of dirt and dust on the globes and reflectors. Frequent cleansing and whitening of the walls would assist toward a desirable consummation, and a proper system of exhaust ventilation would serve to carry off the fumes when pouring is in process. Similar remarks apply to the average smithy, where neglect of the elementary rules in regard to cleanliness and order are responsible for the gloom which pervades these departments.

In fitting and machine shops generally, oil is the principal transgressor against the laws of cleanliness, but modern machinery is generally designed on lines which provide for the proper control of lubrication, even when such lubrication refers to actual cutting edges, and is in the nature of a constant stream of lard oil or oil and water directed against the work, under pressure of a miniature pump. By dint of judicious screening and deflection the average machining operation can be carried out with a mini-

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mum of mess, more especially where due provision is made for the systematic collection and removal of the swarf and scrap and its subsequent treatment in the centrifugal extractors.

The electrical trade, by reason of its characteristics, is one of the cleanest of the lot; but even here, in some large electrical manufacturing works, there is evidence that organisation is lacking in the matter of cleanliness and order. Shellac, paraffin wax, beeswax, and even ebonite, are all messy substances when out of their proper sphere, yet quite easy to control and divert into legitimate channels if only simple precautions are taken. I well remember, in my apprenticeship days, being engaged on the assembly of laminated transformer cores. We boys were furnished with crude jars of shellac varnish, hefty sash-tools, and plenty of tissue paper. Our job was first to insulate the sheet-iron laminæ with shellac and tissue and subsequently build them up, sheet by sheet, into rectangular core frames for the reception of the coils, and a fine mess we made. In due time the floor of that shop was coated with a generous layer of the best shellac, commingled with wire ends, paper fragments, and introdden dirt and debris.

I remember, also, another department where formed wire cables were waxed by dipping in a bath of molten paraffin, and the excess subsequently removed by the primitive process of shaking the ends on the floor. In due course a fine carpet of solidified wax was laid, and, had a conflagration started, it would not readily have been extinguished. Needless to add that with the passage of years came improvements in methods, prompted in all probability by rising fire insurance premiums, and similar processes are now conducted inside the confines of a galvanised steel tank which collects and preserves intact the excess wax. A place for everything and everything in its place is an excellent motto to live up to in every workshop, and every employer has it in his power to effect some improvement, even if only in a small degree, in the conditions under which his employees carry out their tasks.

The war industries connected with the supply of munitions of all kinds demonstrated the possibilities of a proper and orderly handling of all scrap, and, as a result, most large works to-day have departments whose sole duty it is to collect and account for the various scrap materials produced in the several departments. Quite a large revenue is derived from this branch of the business, which can be effectively and profitably offset against the yearly expenditure on essential raw materials. Much remains to be done, however, in the matter of cleaner and better lighted shops; some firms pride themselves on cleanliness and order, and in their shops it is regarded as an offence for a dirty window, machine or floor to remain in evidence. Unfortunately such enterprising concerns are in the minority, and it remains with the leaders of industry to inculcate the habit of cleanliness and order and to abjure waste. A little attention in this direction would go far towards adding to the attractiveness of labour.

ELEKTRON.

DUPLEX WIRELESS TELEPHONY AND SELECTIVE RECEPTION.

The first part of a paper which was read by E. F. W. Alexanderson before the Inst. of Radio Engineers, at New York, recently, deals with duplex wireless telephony, and the second part with the highly selective "barrage" receiver. According to the *Telegraph and Telephone Age*, in the duplex method described the speaker can hear the called party without manipulating a switch to transfer from sending to receiving. For this to be possible it is necessary to neutralise the intensity of the transmitted signal, and the first method that yielded practical results was the use of separate sending and receiving antennæ, located sufficiently far apart that the selectivity of ordinary receiving instruments could differentiate between the wave lengths of the receiving and sending stations. The subscribers and sending stations are connected like two ordinary subscribers on a central exchange, with the only difference that a transformer with its primary winding connected across the line from the receiving station is, by its secondary, permanently introduced in series with the line to the sending station. A telephone current originating in the receiving station is thus transformed into a current flowing in the closed circuit between the subscriber's instrument and the instrument in the sending station. A telephone current originating in the subscriber's instrument will follow exactly the same path. Both these currents will, therefore, be transmitted by the sending station, and both sides of the conversation may, in fact, be heard by a third party tuning his apparatus to the two-wave lengths. This system is suitable for interconnection with wire telephone exchanges.

The most practical method consists in mounting the sending and receiving antennæ on the same masts, and preventing mutual interference between them by inductive or capacitative neutralisation. In the former method, an inductive coupling is provided between the two aerials by a transformer connected in such a manner that it creates in the receiving antennæ a potential opposite in phase to the potential directly induced by the sending antennæ.

The bridge receiving set connections are analogous to a Wheatstone bridge. By adjusting the condensers in the bridge arms extremely perfect neutralisation of the effect of one antennæ on the other is possible. Local stray currents may be effectively neutralised by intercepting them on a wire loop in the neighbourhood of the receiving set and impressing the potential so generated on a little coil mounted with an adjustable coupling close to the secondary loading coil of the receiving set.

The "barrage receiver" is a highly directional combination of aperiodic antennæ with unilateral directional characteristics. When two antennæ are used, the phase difference of the received currents depends on the direction of the incoming signals. By phase-shifting devices and differential coupling to a common receiver the signals from any given direction can be balanced out. Each antennæ is connected to earth through an intensity coupler, the secondary of which is connected to the primary of a phase adjuster, built in the form of an induction regulator. The primary current is connected in split phase so as to produce a rotating field that cuts the secondary windings. The neutralisation of the signals from any particular direction is effected by adjustement of the intensity couplers and phase adjusters.

An experimental set was erected three miles from the New Brunswick station, the wave length of which is 13,600 metres. Nevertheless, signals from Carnarvon, Wales, with 14,200 metres wave length, were received, the signals from the New Brunswick station being entirely eliminated, notwithstanding their intensity and small difference in wave length. By using a double set of phase adjusters, signals from two stations in different directions may be neutralised simultaneously.

Haslingden.—The T.C. are applying to the Ministry of Transport for sanction to borrow £10,000 (mains, £5,000; services, £2,000; sub-station, £3,000).

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AT THE SLOAN ELECTRICAL COMPANY'S NEW SHOWROOM.

THE "PHILLIPS" ¼-C.P. NIGHT LAMP.

On the invitation of the Sloan Electrical Co., Ltd., we recently paid a visit to inspect their new showroom in their extended premises at 8, 10 and 12, Golden Lane, E.C.1, but, before referring further to the showroom, notice should be taken of a new night lamp which is particularly suited to nurseries, dormitories, hospitals, hotels, theatres, cinemas, to switchboards, exits and fire alarms, etc.—in fact, anywhere where it is necessary always to have a small light burning.

The new night lamp is manufactured by the well-known firm of Phillips' Glowlamp Works, Ltd. It is small in size, and can be supplied with bayonet or Edison screw cap, and consumes 1 B.O.T. unit in about 200 hours with a life of about 3,000 hours, so that, if used on the average 8 hours per day, need only be renewed once a year. The light emitted is said to be ¼ c.p., but it would appear to be somewhat higher. It is a diffused glow of a soft yellowish colour, and is produced by a series of electric discharges within the bulb, which contains a thick spiral heater and electrodes in an atmosphere of neon gas (see Fig. 1 for construction). Being very robust, the life is not determined by the strength of the filament, but only by the eventual blackening of the bulb. The lamps are made for use on A.C. circuits from 110 volts upwards, and for D.C. circuits from 150 volts upwards. When ordering, it is necessary to specify the exact circuit voltage, and, in addition, whether for A.C. or D.C.

Reverting now to the showroom: This is artistically designed in oak panels, with green ribbed canvas wall-paper, with polished parquet flooring and a few Oriental rugs, the furniture being Jacobean. Figs. 2 and 3 convey some idea of the artistic taste displayed in designing the showroom, but it is impossible to appreciate the whole scheme without a personal visit. The immediate reason for this development is that the company have been appointed agents for London,

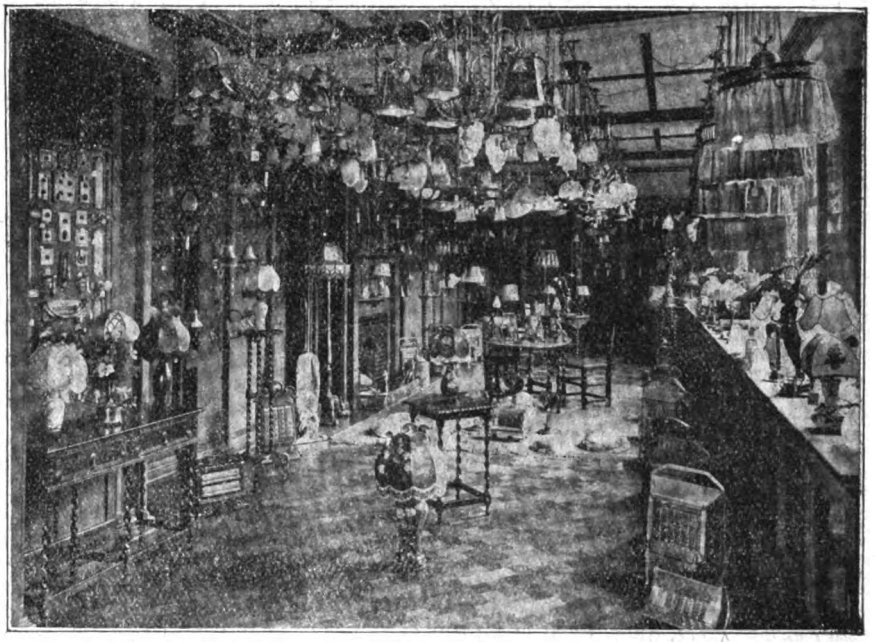


FIG. 2

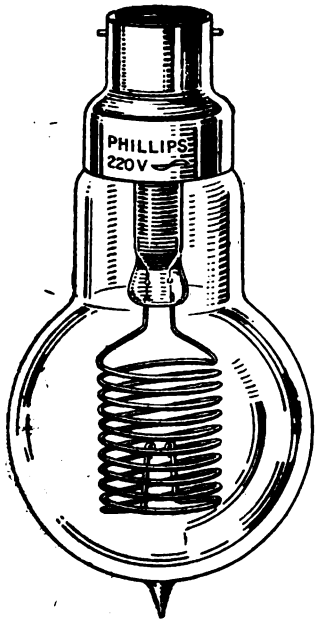


FIG. 1.



FIG. 3.

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South Coast, and East Coast of Scotland, by Messrs. Peyton and Peyton, Ltd., Bordesley Works, Birmingham, manufacturers of decorative electrical fittings and art metal work. This firm has had a large and varied experience in the design and manufacture of fittings for theatres, cinemas and public buildings, having recently equipped the Futurist Theatre, Birmingham, and the Manor Park Cinema. In addition to this class of work, they manufacture a comprehensive range of fittings for ordinary domestic lighting, comprising many exclusive and new designs in dining and dressing room pendants, indirect lighting bowls and other units. The fittings are well lacquered to withstand the various climatic and atmospheric conditions met with. All the classic styles and periods, such as Louis XIII., Louis XIV., Empire, Adam, Georgian, etc., are represented, as well as a choice selection of bronze figures and procelain table standards. In the showroom is a full range of heating and cooking apparatus of the "Slonetric" type, whilst vacuum cleaners and other labour-saving devices, ready wired for demonstration and display, are also included.

Finally, we are informed by the Sloan Electrical Co. that they will be pleased to forward an up-to-date catalogue, also an introductory booklet, post free on trade application.

ELECTRICITY SUPPLY.

So far the progress made towards the formation of Joint Electricity Authorities is not particularly encouraging. Some 13 proposed electricity districts have been delimited by the Electricity Commissioners. A few inquiries have been held and others come up for hearing in the near future, but only in compact industrial districts has any measure of success been attained; nor does it seem likely that much will be attained, as until the Commissioners are armed with compulsory powers, they have but little authority That authority would be provided by the passage of the Electricity Supply No. 2 Bill through Parliament, but seeing that opposition to it is daily getting more determined and that the Government appears wisely to be changing its spendthrift habits, as evidenced by the decontrol of coal, the cutting of expenses and the repeal of Part I. of the Agriculture Act, etc., its chance of being passed appears now rather remote. The country as a whole wants no more Municipal or Government enterprises involving the borrowing of money or the spending of taxes, and feels that a cheap and abundant supply of electricity can be provided under existing powers (which are really quite wide) aided by the advice, and such pressure as it can exert on unreasonable bodies, of the Electricity Commissioners. Companies can generally carry on the business of electricity supply at least as well as local authorities, though there certainly are many instances where the local authorities have made a good showing—particularly in large towns where there is little chance to go wrong.

As an instance of the obstructive and dilatory tactics of some local authorities the following is of interest:—The Ellesmere U.D.C. hold an electric lighting order, but have been advised by the Commissioners that they have no prospect of a supply for several years, except from the Mersey Power Company, and they must either transfer the order on very satisfactory terms or have it revoked.

When the matter came up for consideration at the U.D.C. meeting many councillors were extremely annoyed at having to part with their hopes of becoming monopolists in the supply to the ratepayers of power and light. Apparently, said a councillor, they were going to be at the mercy of a private company. What was to stop the Mersey Power Company supplying electricity to householders at a cheaper price than the Council's gas? He hoped the Council would fight the matter. He moved they fight it out, and refuse to transfer the order without some explanation as to why they were being so treated. Eventually it was decided to inform the Electricity Commissioners that the Council were unable to make their decision yet as promised and to ask for full particulars and the reason why they should be called upon to surrender their order to the Mersey Power Company.

With regard to the supply in rural areas the only solution is direct supply from a power company's overhead mains. Where the local authorities can overcome their aversion to not doing the thing themselves, they should assist the various power companies to utilise their powers or where necessary, help them to obtain extended powers. According to recent news it appears that the Hinckley R.D.C. has been opposing the grant of an order to the Mid. E. L. and P. Coy. to supply the village, simply because it wanted to do it itself, though this would involve a duplicate set of mains. They were, however, compelled to waive their objection.

Finally it must be remembered that there is now every indication that farmers and landowners will be demanding a supply as, without it, it will be impossible to produce economcally, while paying anything like the improved wages now enjoyed by the employees. If the supply cannot be obtained from a public authority, a farmer or landowner can have his own generating plant or if there is a demand in a district an "unauthorised" or non-statutory supply can be given by a private individual or company, but in this case the consent of the Commissioners must be obtained. They are, however, in such cases, only concerned with the kind of current, voltage and frequency, if A.C., with the object of fitting in the scheme with the large Joint Authority Scheme, should such ever be set up in the district. The collapse of the Lower Severn District scheme, owing to the long distance between towns and its unremunerative nature on such a large scale is not, however, a hopeful augury for these districts.

Under Clause 11. of the Electricity (Supply) Act, 1919, it is not lawful for any authority, company, or person to establish a new generating station or main transmission line without the consent of the Electricity Commissioners. The same clause, however, provides that their consent shall not be refused or made subject to compliance with conditions to which the applicant objects unless a local inquiry has been held

This clause is obviously framed with the large authorised undertakings in view, but for the provision of supply by overhead wires in a very small isolated town or large village and the adjacent country, the Commissioners are not in the least likely to go to the trouble and expense of a local inquiry—at any rate, this is the opinion of our esteemed contemporary *The Electrical Contractor* and we see no reason at all to doubt its correctness, and, although "unauthorised" supply is in a somewhat anomalous position, as it is non-statutory though "authorised" by the consent of the Commissioners, anyone who worries over the illogicalities of British legislation, again to quote from our contemporary, will never get any sleep or develop any enterprises whatsoever.

With regard to the large industrial and business areas the position is quite different and the proceedings at the inquiry into the London Electricity District make interesting reading.



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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO 121.

Can any reader give me full details of the use and operation of the Tesla coil?—J.E.H.

QUESTION NO. 122.

Please can any reader give me full details of checking the ratios of various transformer connections, preferably "Scot, Zig-zag, etc."?—J.E.H.

(Replies to Questions Nos. 121 and 122 must be received not later than July 30, 1921.)

Trade Notes.

Having just completed considerable alterations and extensions at their City Warehouse, 123-5, Queen Victoria Street, E.C.4 **The Edison Swan Electric Company, Ltd.**, desire it to be known that as and from July large stocks of lamps, fittings, accessories, etc., in the London area will be dealt with from there instead of from the Works. This new arrangement should effect a considerable saving in time to customers.

The Photector Co. Ltd. (Southall), make 14 sizes and 4 types (total 56 patterns) of wrought copper cables, sockets, tinned all over. These are listed and priced with full dimensions in leaflet E 2030, which also contains an extract from the B.E.S.A. Report, No. 7, on the international standards of resistance for copper. The leaflet will be found useful by the trade, who are invited to apply for it.

An illustrated price list and folder dealing with "Cosmos" electric domestic devices have recently been issued by the **Metropolitan Vickers Electrical Co., Ltd.** (Trafford Park, Manchester). Kettles, irons, jugs, hotplates, grillers and toasters, urns, switches, plugs, connectors and the "M-V" super switch-plug are among the items listed. The latter item and the "Cosmos" new type connector for heating apparatus should be carefully investigated by those who have not yet done so. The "Cosmos" radiant bowl fire (550 watts) is also fully treated and will be dealt with separately.

A gasfilled lamp of especial value to artists, dyers, textile manufacturers, and for shop lighting, etc., where the accurate matching of colours is essential, is the Royal "Ediswan" "Daylight" lamp. The lamp is standard in every way except that the bulb is of a special colour glass which absorbs the red rays in such proportion that the resulting illumination closely resembles the North sky light. No special fittings are required, and the prices are 25 per cent. above those of the standard gas-filled lamps. These "Daylight" and the "Ediswan" "Fullolite" (opal glass bulb), lamps are dealt with in a new list, No. LL 229, to be obtained from the **Edison Swan Electric Co., Ltd.** (Ponders End, Middlesex).

The Overseas Engineering Co., Ltd. (Manufacturing Electrical Engineers and Export Agents, 163-5, Great Portland Street, W.1), send leaflets dealing with (1) "National" volt and ampere meters; (2) the "Overseas" vacuum cleaner, which has among its features a transparent dust indicator to show when the cleaning is complete—no dust then passing—a swivel point which permits cleaning without moving the furniture and steers the floor tool; and a paper dust container, which is removed and burned with the dust. A third leaflet deals with the "Garge" current converter for charging accumulators from A.C. Another speciality is the "Overseas" automatic or semi-automatic lighting plant for 30, 50 or 100 lights (32 or 110 volts). When getting short of petrol a bell is rung.

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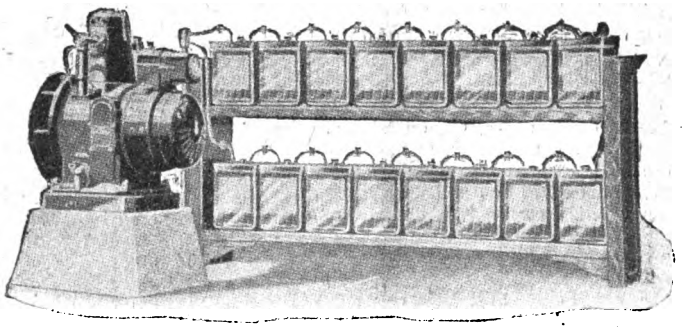
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UNDERGROUND HAULAGE BELLS AND TELEPHONES: TROUBLES AND THEIR REMEDIES.*

By J. S. KENDAL.

(*Continued from page* 355.)

BELL TROUBLES.

The troubles met with in colliery bell systems are so varied in nature that it is a difficult matter to give a definite solution which would apply to all similar cases. They are sometimes peculiar in their effects and often so puzzling as to be quite beyond any satisfactory explanation. Faults may be caused accidentally, sometimes wilfully, occasionally by people with good intentions, and often by people with no ideas at all. A few examples might serve to illustrate this.

On a certain haulage road with a very low roof the engineman often received a "hold" signal which always occurred when the set was rounding a particular curve. Interference by some unknown person was suspected but investigation showed that the lines were slightly slackened at this point and were bridged together by the iron hoops of the tubs as the set was passing beneath. On another road similar signals were received at irregular intervals and could not be accounted for, as the system was in good order. The trouble continued for about three weeks and was eventually solved by one of the officials observing a greaser boy tampering with the lines, and examination of his pocket-knife pointed to the fact that he was responsible for the stoppages, which ceased when he was removed. Another case of wilful interference was where a night-shift worker, evidently a budding electrician, used the bell batteries to amuse himself with the working of some small models, with the result that the battery was run down and of practically no use when required the following morning. Yet another case occurred when, on switching in the battery one morning, the bells began to ring continuously. Crossed lines were naturally suspected, but after a man had gone along the road without any result, he became annoyed. On making a more minute search the trouble was found to be caused by a piece of very fine wire of the sort used by florists, which had been fastened to one line at an insulator on a baulk, then carefully hidden behind the timber and brought back again to the neighbouring insulator and line.

Another fault which kept a man hunting for an hour or more occurred on a system which was reported out of use one morning. The nature of the fault was soon found to be an open circuit in the line between two stations about half a mile apart, but the question was, at what exact point? Probable places were first examined, but it was only by sectionalising and testing that the fault was found in a long length of insulated wire near the bottom of a drop staple. This wire had been accidentally broken the previous night, and the lad attending the staple had attempted to repair it. He had made a fairly decent joint and had even covered it with a piece of old tape, but he had quite omitted to bare the two wire ends before making his joint. In another case a similar breakage was "repaired" by someone tying a piece of string across the two broken ends.

A prevalent source of trouble is due to repair gangs tying the lines together or tying them to girders during timbering operations. A little advice in this respect is sometimes useful, but it is feared that many men would rather cut a wire down altogether than remove it aside. The majority of signal troubles, roughly about thirty per cent., appear to be due to the lines or trouble connected therewith. In many cases this can be directly ascribed to the conditions of the roadways, but even on bad roads the troubles can often be greatly reduced by a suitable arrangement of the wiring. The ideal roadway is undoubtedly a brick-arched one in which bare lines may conveniently be run without fear of interference from falls of roof.

*Paper read December 18, 1920, before the North of England Branch of the Association of Mining Electrical Engineers.

In order to show the extent to which the roadway itself may be responsible for signal faults when using ordinary methods of wiring a comparison is given between a good and a bad road:—

No. 1 Road, 1,500 yd. of double line ... 1 fault.
No. 2 Road, 240 " " ... 12 faults.

The records cover a period of six months, and an attempt was made to reduce the number of faults in the second case by substituting 7/21½ V.I.R. cable in place of the bare wires, with the result that the line faults for the next six months were 0 and 3 respectively. Practically total freedom from line trouble may be obtained where the roof and roadway timbering is kept in good repair, and in this respect a great deal depends upon the good will and co-operation of the underground staff of the colliery.

Appended is an analysis of a record of faults covering a period of eighteen months.

A Record of Faults occurring on Underground Haulage Signal Systems during a period of Eighteen Months.

	First 6 mths.	Second 6 mths.	Third 6 mths.
Lines on Roadways—			
Broken	15	12	14
Earthed	3	2	5
Crossed or Twisted	12	11	11
Bad joints	7	3	3
	37	28	33
Wiring connections to bells—			
Broken	6	5	6
Earthed	7	7	9
Loose connections	0	5	2
	13	17	17
Battery faults—			
Broken jars	0	2	5
Broken pots	2	1	1
Zincs	6	7	5
Miscellaneous	7	7	4
	15	17	15
Bells—			
Coils	1	1	0
Broken gongs	2	0	0
Loose gongs and stands	2	7	1
Loose and bent hammers	4	2	4
Adjustments	14	14	9
	23	24	14
Keys and Pushes—			
Damaged	1	2	0
Broken contacts	6	0	1
Sundry faults and adjustments	5	2	7
	12	13	8
Permanent Way			
Derailed sets	1	3	4
Broken ropes and couplings	1	2	0
Roof falls	4	7	5
Timbering, etc., workmen	0	0	3
Lines fouling sheaves, pipes or ropes	7	3	3
	13	15	15
Miscellaneous faults—			
Intermittent trouble	3	2	0
Relays	0	0	1
Switches	0	2	3
Dampness in gear	0	1	1
Wilful	3	4	1
Unknown	2	3	4
Sundries	0	2	1
	8	14	11

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	First 6 mths.	Second 6 mths.	Third 6 mts.
Total number of faults ...	121	128	113
Average number of bells in use	36	42	33
,, keys ,,	38	41	44
,, cells ,,	107	112	102

A summary gives the average percentage of faults due to various causes as follows: —

Faults due to lines	27.1%	of total faults
,, wiring	13.0%	,,
,, batteries	13.0%	,,
,, bells	16.8%	,,
,, keys	9.1%	,,
,, permanent way, etc.	11.9%	,,
,, miscellaneous ...	9.1%	,,

Average time taken to remedy faults, including travelling—84 minutes.

Average duration of stoppages where such have occurred—62 minutes.

One sometimes comes across a case where neither a single-stroke bell nor a trembling bell is of much use, for instance in a noisy engine-room where the bell cannot be heard whilst the engine is working. This is often due not to the weakness of the bell but probably to the tone of the bell being similar to that of the sound caused by the engine, as, for example, the peculiar ringing noise caused by steel gears. In such circumstances the trouble can often be overcome by substituting a gong of a different tone or the note of an existing gong may be altered by a few saw-cuts around its outer edge. Obstinate cases may be cured by using buzzers or motor-horns in place of bells, but in one instance even this remedy was of no avail and the difficulty was only overcome by the adoption of a luminous signal worked from an accumulator by means of a relay in addition to the bell.

(To be continued.)

Various Items.

Industrial League Council.—Messrs. E. J. P. Benn and F. Elliott are to be entertained to dinner at the Holborn Restaurant on July 14, at 7 p.m., on their return from America. The Chair will be taken by Viscount Burnham, C.H. It is suggested that each employer bring at least one workman or Trade Unionist with him. Tickets, 10s. 6d. each, from Gen. Sec., 82, Victoria Street, S.W.1.

Telephone Material Wanted.—The Ministry of Posts and Telegraphs, Belgrade, is inviting tenders for various telephone material by July 13. Apply D.O.T., Room 49, 35, Old Street, S.W.1. It is almost essential that U.K. firms competing for Govt. contracts in the Serb-Croat-Slovene State should do so through an agent in that country. The D.O.T. is prepared to render its assistance in this matter.

Agents Wanted.—Live and pushing trade readers who are on the look out for agencies should make a point of applying to Willys Overland Crossley, Ltd., at Heaton Chapel, Manchester, for particulars of the agencies to which they referred in their full page advert. in last week's issue of this paper and also in the current issue. These sets hold a very high reputation, and applications for agencies should be made without delay.

Accrington.—The Electricity Committee has revised its scale of charges from July 1, following the loss of £12,000 on the undertaking last year. It is estimated that the increased charges, which are based on an annual output of 9,000,000 units, will produce an additional revenue of £12,000 per annum. The scale includes: lighting, flat rate, 8d. per Board of Trade unit; heating and domestic purposes other than lighting through separate meter, 3d.; with a minimum charge of 5s. per quarter during the summer and 10s. per quarter during winter. Rateable value basis; alternative tariff for domestic lighting, heating and power. A fixed charge of 15 per cent. per annum on the rateable value of the house occupied, plus a charge of 2½d. per unit for all units consumed. Consumers electing to take a minimum of 15,000 units per month for a year will be charged on the following scale: from 15,000 to 40,000 per month, 1.2d.; 40,001 to 80,000, 1.15d.; 80,001 to 160,000, 1.1d; over 160,000, 1.05d., subject to a fluctuation based on the cost of fuel of .02d. per unit for each 10 per cent. rise or fall above or below 10s. per ton.

Montevideo.—59,250 metal filament lamps, 225 volts, 10 to 300 c.p. are required by the State Power House. Tenders by Sept. 3. Local representation, as usual, is essential. Further information can be obtained from the D.O.T.

Edmundson's.—The report of Edmundson's Electricity Corporation, Ltd., reveals that for the year ended March 31, 1921, after meeting all charges, the net profit amounts to £16,053 as compared with £8,099 for the previous year. £12,000 goes in dividend on the Cum. Prefs., and £14,142 is carried forward (last year £10,089).

Burnley.—The Electricity Committee, on June 23, considered the question of increasing charges for current, and decided to revise the scale as follows:—For power purposes, for the first 39 units used per quarter of maximum demand, from 2.57d. to 2.90d. per unit, and for all units above from 1.75d. to 2.08d; for heating and domestic purposes, from 2.2d. to 2.53d. per unit; lighting from 5½d. to 6d. per unit; for traction, 1.9d. to 2.1d. per unit.

Merthyr Electric Traction Co., Ltd.—The 1920 report of this company states that the capital expenditure amounted to £10,016, making the total expenditure on traction undertaking £75,454, and on electricity supply undertaking, £92,124. Revenue totalled £52 105. After deducting all expenses, including debenture and other interest, and placing £1,200 to reserve, a dividend at the rate of 6 per cent. per annum on ordinary shares has been paid, leaving £1,429 to be carried forward.

Motor Coach A.B.C.—We are in receipt of the first issue of the Motor Coach A.B.C., which is to be a monthly guide, published at 6d., for the British Road Traffic Association (54, George Street, Portman Square, W.1), by E. J. Larby, Ltd. The guide is easy to use and embraces motor coach and motor bus services throughout the country, as well as river, sea and air travel. We can see that it will soon be as indispensible as the railway A.B.C. The Road Traffic Association is to supplement the work of the commercial vehicle owner in every way possible and by its organisation helps in the co-ordination of freights and users of commercial vehicles for the carriage of their wares get considerable benefit from membership.

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JULY 8, 1921.

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A DEVELOPMENT IN TRAIN SIGNALLING OR CONTROLLING.

Many train signalling and controlling systems depend upon some form of apparatus which makes or breaks a circuit when an engine or vehicle passes over a given position on the line. Many forms of contact for this purpose have been devised, but the majority of these involve interference with the permanent way. An improved instrument (Patent No. 3405/14) which can be quickly installed without interfering with the track is now being manufactured by the General Electric Co., Ltd. (Magnet House, Kingsway, W.C.2). It is called the Sleeper Contact, and, as its name suggests, it is fixed on the sleeper or tie, and although primarily intended for use on wooden sleepers, it may be fitted on either steel or concrete. It is portable, simple in construction, and, it is claimed, is independent of the type of rail or rail fastening, and its action is not affected by the

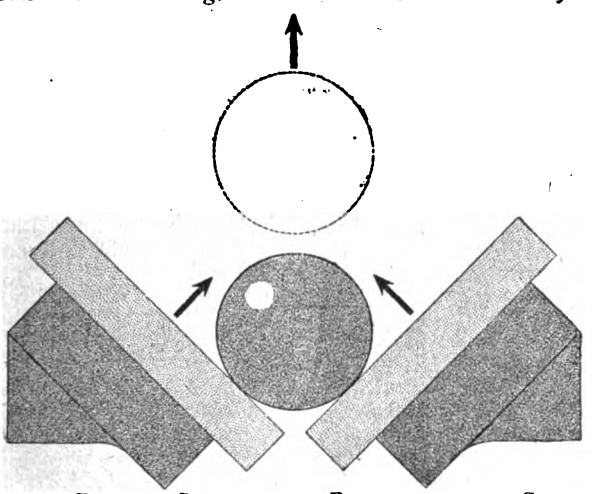


FIG. 1.—DIAGRAM SHOWING THE PRINCIPLE OF THE SLEEPER CONTACT.

"creeping" of rails. There is a "normally made" contact, and when a train passes over the sleeper the vibration causes the circuit to be broken, contact being re-established by gravity. The principle upon which the apparatus works will be made clear by reference to Fig. 1. Two stout metallic reeds, inclined to each other at an angle of 90 deg., are firmly clamped to, but insulated from, a boss in the bottom of the iron case. A carbon electrode is fixed to each opposing face of the reeds, and the V-shaped gap between them is bridged by several carbon balls which form the electrical connection. Connections from each reed are brought out to standard terminals on the outside of the case.

The reeds are adjusted to vibrate in unison, and when they are set in motion by the vibration of the rails, the carbon balls are thrown vertically upwards, thus breaking the circuit between the reeds. When the reeds cease to vibrate the balls return to their original position in the V-shaped gap, and contact is once more made. An insulated retainer is attached to the box to locate the carbon balls when the contact is not in use. The contact is fixed to the sleeper by three bolts passing through lugs cast on the base, but as the instrument is specially suitable for use in an emergency, or for temporary use where portable apparatus is required, a special screw is attached to the case, by which the contact can be screwed down by an unskilled person without the use of tools. The weight of the complete contact is 6¼ lb., and the overall dimensions are 6 in. by 4 in. by 2½ in.

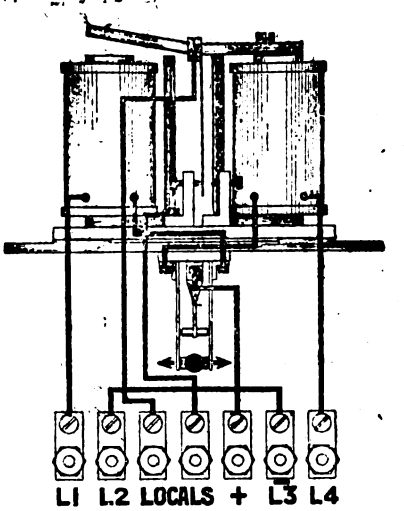


FIG. 2.—DIAGRAM OF INTERNAL CONNECTIONS—TYPE G CONTROLLER.

Severe tests under working conditions have shown that the contact will respond to the movement of a train travelling at two or three miles per hour, but is unaffected by trains passing on an adjacent line at 60 miles per hour.

For use in conjunction with the Sleeper Contact, controllers (Patent No. 157498) have been designed to give visual or audible signals. Fig. 2 shows the internal connections of the type G controller, which may be arranged either with "normally open" circuit to operate a bell, hooter or lamp, or with "normally closed" circuit to control such apparatus as a lever lock on the gates of a level crossing, or an indicator. In either case the local contacts are operated by the break in the circuit when the Sleeper Contacts are actuated by the train. Two electro magnets, fixed vertically side by side, influence a common armature pivoted centrally between the pole pieces. A current from a common source divided equally between the two windings will result in the armature holding against one of the pole pieces. If the circuit through coil A be broken the magnet is de-energised and the armature will be attracted to pole B, at the same time making or breaking the local circuit. When the circuit through coil A is re-established, both magnets are energised, but as the gap between the armature and the pole piece A is now much greater than that between the amature and pole piece B, the armature will not move. When the circuit through coil B is broken, the armature will be attracted by magnet A, thus reversing the local contacts. The circuit through "B" is next made, but as the gap at B is greater than at A the armature is not attracted, and the apparatus is left in the original position. The breaks in the circuit would, in practice, be

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caused by the train actuating sleeper contacts inserted in series with coils A and B.

A decisive and rubbing action is given to the local contacts by the movement of the armature, thus ensuring that the contact surfaces are kept clean. A bias is fixed to the armature so that a safe signal is given in the event of battery failure or discontinuity of the circuit. A test and stop key is fitted, which provides a ready means for a non-technical user to ascertain whether the apparatus is in working order. The stop key can also be used to arrest a signal given either automatically or manually. This key can be locked by a simple arrangement inside the case so that either or both uses can be prevented, or it may be sealed over if it is only to be used in emergencies. It is mounted in a cup in the cover so that it cannot be operated accidentally. For visual indication, other indicators, suitably modified, are supplied.

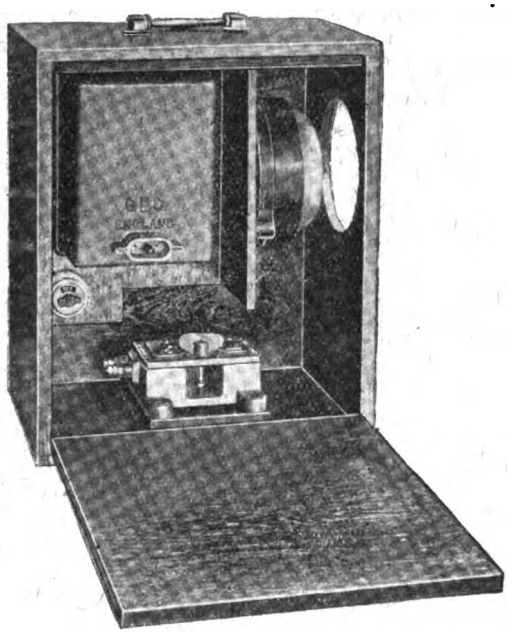


FIG. 3.—PORTABLE WARNING SET (WITH SIDE DOOR OPEN).

A complete portable Sleeper Contact which can be carried by one man and installed by persons having no technical knowledge is shown in Fig. 3. It is designed to give warning to men working on the permanent way, and comprises a controller, battery, special stop key and bell, mounted in a case in which a Sleeper Contact is housed when not in use. The battery can be easily removed for charging. This set could be carried out with the gang, and the Sleeper Contact screwed to a sleeper at a suitable distance from the spot where the men were working. A twin cable, which need not be of low resistance, would be connected to the Sleeper Contact, and laid along the side of the track to the point at which the look-out man was stationed, where it would be connected to the two large terminals on the portable set. When the train reaches the Sleeper Contact the bell will ring and continue to do so until the large button, fitted in the recess in the case, is pressed.

MISCELLANEOUS APPLICATIONS.

Other applications which suggest themselves include:—(1) Operating signal replacers or other devices requiring a "normally made" circuit. (2) In positions where an advance starting signal is out of sight from the signal box, a Sleeper Contact fixed just ahead of the signal could be arranged to give an indication to the signalman that the engine had passed the signal, thus enabling him to put the signal to "danger" at the right time. (3) For use in automatically recording the speed of trains, in conjunction with some other form of chart recording instrument, or by using a type G controller. (4) For recording the passage of trains, using a counter attached to the controller. (5) Level crossing gate control. (6) Warning for men working in tunnels or painting or repairing bridges, etc.

THE LONDON ELECTRICITY PROBLEM.

(*Continued from page* 358.)

Alderman Duncan Watson, the Chairman of the Conference of Local Authorities promoting the second of the schemes before the Commissioners, which was outlined in our last issue, gave evidence during the whole of Wednesday and part of Thursday, June 22 and June 23, and was followed by Mr. C. H. Wordingham, who has collaborated with Sir Alexander Kennedy, Mr. G. W. Partridge, and Mr. J. H. Rider, in the preparation of the engineering proposals. The engineering scheme already described by Mr. Rider is common to the L.C.C. scheme, the Local Authorities' scheme, and the scheme promoted by the nine London companies. This latter was outlined to the Commissioners on Friday, June 24, and was found to differ in several important respects from the two previous schemes. The two most important points of difference, perhaps, are the area and the constitution of the joint electricity authority. It has now been made abundantly clear that the engineering operations which are likely to be carried out during the next few years are agreed by all parties, and the main task of the Commissioners will be to evolve an administration scheme for giving effect to the engineering part.

The nine London companies which have formed themselves into the London Electy. Joint Committee (1920) Ltd., are the London Elec. Supply Corpn., the Charing Cross West-End and City Co., the Metropolitan Elec. Supply Co., the Central Elec. Co., the Westminster Elec. Supply Co., the Kensington and Knightsbridge Co., the Brompton and Kensington Co., the Chelsea Elec. Supply Co., and the St. James's and Pall Mall Co. Instead of accepting, as did the two previous proposals, the large area delimited provisionally by the Commissioners, which includes not only the County of London but considerable portions of the surrounding counties, this scheme by the nine companies has taken an area enclosed in a circle having a radius of ten miles, with St. Paul's Cathedral as the centre. In this it will be seen is concentrated the greater portion of the load of the larger area; in fact, the Commissioners were told that whereas the demand inside this circle is 432,866 kw., the remainder of the area scheduled by the Commissioners represents only another 32,400 kw., of which 25,000 kw. is applicable to the North Metropolitan Elec. Power Co. Further, the nine companies putting forward this scheme supply 93 per cent. of the total load in the circle. The reason for adopting this limited area is that the promoters do not consider it would conduce to economy to give a joint electricity board administrative powers over such a large area as that delimited by the Commissioners. At the same time, the scheme has been so arranged that outside authorities can come into it by way of mutual supply.

Coming to the constitution of the proposed joint authority under this scheme, there is the important difference that whereas in the two previous schemes a definite limit is placed to the number of representatives, in this case no such limit is imposed. The L.C.C. is allocated five representatives; one representative is proposed for the City of London Corpn.; two representatives from local authorities outside the County of London, who may have transferred purchase rights over companies to the joint authority; whilst railway companies and large users are given three representatives. The Chairman and Vice-Chairman are to be elected independently, but in addition to all these it is proposed to give one representative to every authorised distributor in the area—and there are 44 of them—which enters into an agreement to take a supply from the joint authority or has a loan of £100,000 to the joint authority outstanding,

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or guarantees the interest on a similar amount, one vote being given for every £100,000.

The essence of this scheme, as well as that of the Conference of Local Authorities, which preceded it, is voluntary working between the authorised distributors, whereas under the L.C.C. scheme the joint electricity authority would have power to compel authorised distributors to come into the scheme. The advocates of voluntary working point to the large amount of linking up that has taken place in the London area during recent years, without any compulsion from an outside authority, and it is even argued that the joint authority, at any rate in the first place, might consist of a committee of the engineers of the authorised distributors, which would supervise a further extension of the principle and bring it about much more easily and at less expense than a constituted authority with compulsory powers.

All the schemes so far placed before the Commissioners have ignored the railway load in the estimates, the reason being that there has been an impression on the part of the engineers responsible that the railway companies will not come into any such scheme, because they could generate energy for themselves more cheaply in independent stations than they could obtain it from a joint authority. It was only after this argument had been used for eight days that the railway companies came forward with the statement that they were quite prepared to buy in the cheapest market. The main reason why it had been said that the railway companies could supply themselves more cheaply than the joint authority was that the latter would have to provide a sinking fund for repayment of its capital, which the railway companies would not, thus forcing up the price of energy in the case of the joint authority.

(To be continued.)

LICENSING OF ELECTRIC WIREMEN.

We learn from the *Industrial Australian and Mining Standard* that the State Electricity Commission of Victoria has issued new rules, which came into operation on May 16, relating to the licensing of electric wiremen. Under the new rules persons who, for gain or reward, carry on or are engaged in the work of the installation of the wires and apparatus used for utilising electricity supplied by an electric undertaker must be licensed.

There are three grades of licence :—An "A" grade licence is issued to (1) persons applying before October 1, 1922, who are over 21 years of age, and have been engaged as wiremen for at least seven years prior to the date of their application, and have passed the prescribed examination; or (2) apply after the date referred to, and have been engaged as wiremen, and have held a "B" licence for a period of at least five years prior to the date of his application, and have passed the prescribed examination.

An "A" licence entitles the holder to carry out the work of installing wires, etc. He shall be responsible for good workmanship, and shall see that all work under his charge is carried out in accordance with the regulations. He shall be responsible for all notices that may be required to be given to undertakers, municipal councils, etc.

A "B" grade licence may be issued to any person over 21 years of age who has been engaged as wireman for a period of at least five years prior to the date of his application, and has passed the prescribed examination, and shall entitle the holder thereof to carry out electric wiring work under the supervision of a holder of an "A" licence, but not otherwise. The holder of a "B" licence shall be responsible for any work done by himself or by any holder of a "C" licence who may be under his charge.

A "C" grade licence may be issued to persons under the age of 21 years, and shall entitle the holder to carry out electric wiring under the continuous and direct supervision of the holder of an "A" or "B" licence, and not otherwise, and only while in the employment of a stated employer. He must be engaged either as an apprentice or an improver for at least five years before he is eligible to become an applicant for a "B" licence, except under stated conditions.

Australia always was more advanced than the U.K., but apparently anyone may wire his own house and get connected without trouble.

MOTORS AND STARTING GEAR.

Some useful notes on motor starting gear are contained in the July issue of the Monthly Magazine of Higgs Bros. (Sand Pits, Birmingham). The first motor was turned out in 1912, since when the business has rapidly progressed and is still growing, aided, no doubt, by the little magazine, which besides its valuable stock list, always gives its readers useful information together with pictorial and verbal humour, from which we quote the following :—

"Why do Higgs' machines always look so clean? Well, the fact is, they are fitted with brushes. That's why they look so clean when you get them. We also send you two spares with each machine, so there's no excuse if you don't keep it clean too. Incidentally, we also fit a fan to blow the dust away.

"Higgs' squirrel cage motor is an exceedingly cheap proposition. So much so, in fact, that we really can't supply any more squirrels to go with them, except at an extra charge. A quantity of fodder is supplied, however, in the form of nuts.

"D.C. machines are all fitted with rockers. Poor things! They carry tremendous loads without complaint, why shouldn't they have a little comfort in their spare time?

"All machines carry keys—but not in bunches. True, most of us like to have ours in more accessible positions, but then, perhaps, we are more inclined to break out and have a bust—in which case, one likes to have the front door key handy.

"N.B.—It's a good tip to leave it in the lock when you go out."

All purchasers of motors should ask Higgs Bros. to put them on the list of recipients of this magazine and stock list.

I.E.E. CONVERSAZIONE.

Included in the 1,600 guests at the I.E.E. Conversazione held in the Natural History Museum on Thursday, June 30, were Sir William Barrett, Sir Tom Callender, J.P., Sir G. H. Collier, Sir Robert Elliott Cooper, Sir H. J. Creedy, Sir Philip Dawson, Sir G. K. B. Elpinstone, Sir Arnold B. Gridley, K.B.E., Sir F. S. Hamar, Brigadier-General Sir W. T. F. Horwood, Sir Herbert Jackson, Rear-Admiral F. C. Learmouth, Sir Gerard and Lady Muntz, Sir Philip Nash, Sir A. M. J. Ogilvie, K.B.E., C.B., Vice-Admiral Sir Laurence Power and Sir A. W. Watson.

There were also present 20 Members of Council, Mr. P. F. Rowell (Sec.), and the Deputation of American Engineers. After introductions by the President of the Institution, supported by Mrs. Atkinson, the Chairman of the Deputation conveyed a message of appreciation by American Engineers of the work done by British Engineers in the war, and Dr. F. B. Jewett conveyed fraternal greetings from the American Inst. E.E.

A programme of music was rendered by the String Band of the Royal Engineers, and a concert by Phyllis Carey-Foster, May Peters, and the Allied String Quartette—all the items being much appreciated.

Sennybridge.—With further reference to our recent note concerning the formation of the Sennybridge Electric Supply Co., Ltd., we are now able to state that the contractors for the installation of the plant were Harold Elston and Co. (The Modern Garage, Brecon). Local contractors should note that the plant is running satisfactorily, some consumers have been connected and others are arranging for a supply. The Secretary to the Company is Mr. N. Williams (Bryncelyn, Sennybridge, Breconshire).

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THE FUTURE OF THE SHIPBUILDING INDUSTRY.

In the course of a conversation with a pressman on the 25th ult., a director of a big shipbuilding firm expressed himself rather pessimistically with regard to the future of shipbuilding in the United Kingdom. He said that there were about 5,000,000 tons of shipping on the stocks of the United Kingdom, and a large proportion of that needed little to complete it for service. In addition to the 5,000,000 potential tons on the stocks, there were about 6,000,000 tons of unemployed shipping tied up. A great deal of this 6,000,000 tons could be bought at from £8 to £10 per ton, or considerably less than it cost, and he fancied that a large proportion of it would be absorbed before the 5,000,000 tons on the stocks would be completed. The outlook, he considered, was anything but good for at least five years to come. Freight carrying cost would have to come down as the tonnage came in, and there would be little incentive to complete the new ships. Money, too, he added, was very tight, and that was a very important factor in completing the ships.

ECONOMY IN ELECTRIC COOKING.

According to *Helios*, two new equipments for electric cooking have recently been placed on the market in Germany. In both cases the principle employed is that of the old fashioned hay-box in conjunction with thermostatic control. The cooking utensils are surrounded by heat-insulating material in a suitable outer box or container. Current is switched on in the usual way until the desired cooking temperature is attained. A thermostatic switch then opens the circuit and cooking proceeds by the heat stored in the food and in the cooker itself. Directly the temperature drops appreciably the thermostatic switch restores current flow until the upper temperature limit is again reached.

The equipment can be used for boiling purposes and also, it is claimed, for roasting, baking and sterilising, etc. In the apparatus as designed by Reinhold (Leipzig), silite rods are used as heating elements, and the power consumption is about 800 watts in the case of a cooker large enough for a family of six or eight persons, and capable of holding four pans simultaneously. On the average current is flowing for about 50 minutes during a cooking period of 3 hours.

A time switch can be used in conjunction with the cooker to open the circuit at any predetermined time. This, in conjunction with the temperature switch, ensures that food cannot be either overheated or cooked too long. The constant temperature maintained by the thermostat is adjustable at will.

Whilst this apparatus is most ingenious and interesting we are inclined to doubt whether it shows much advantage in point of energy consumption compared with standard British types of cookers. In any case, since electricity is very cheap, we personally should prefer to have the greater scope and flexibility of the ordinary electric oven. On the other hand, it is clear that the thermostatically controlled apparatus would be very useful to those who have no one at home to prepare a hot meal against their return.

INDUSTRIAL ELECTRIC PLANT.

Some valuable information on industrial electric plant is given in Vol. I., No. 6, of the *English Electric Journal*. First there is an extract from the speech delivered by the chairman of the English Electric Co., Ltd., Sir Chas. Ellis, G.B.E., K.C.B., at the recent Annual General Meeting, then follows a fully illustrated article on electric winders by Mr. J. Kirkwood. The design and use of electric locomotives is fully treated and also the various types of English electric industrial motors for A.C. and D.C. circuits. Ball and roller bearings are used throughout the range of these machines, and as some users are still prejudiced against their use it is instructive to read the article in the same issue by Mr. P. Howden, who, we understand, is chief electrician to one of the largest firms of machine tool makers in the country. Other articles deal with the modern steam condenser and with small and medium size transformers manufactured by the Company, whose London offices are at Queen's House, Kingsway, W.C.2, while the works are at Coventry, Preston, Bradford, Stafford and Rugby.

WORLD'S TELEPHONIC DEVELOPMENT.

From figures published in the *Telegraph and Telephone Journal* to December 31, 1919, W. H. Gunston, in *Telephony*, for April 16, contributes an interesting article giving particulars for all countries. The figures are based on recent official information, except in the case of a few countries where recourse has had to be made to estimates computed from the latest obtainable figures. Despite the war, in which all the larger telephone-owning countries (except Sweden) were engaged, the total number of telephones in the world has increased from about 14,500,000 in 1913 to 19,370,000 in 1919. In Europe the increase is from 3,950,000 to 4,880,000.

The total number of telephones in Europe is approximately 4,880,000, giving a ratio of one telephone to 82 inhabitants. This proportion would be much better if Russia, Spain and the Balkans were excluded. It is a remarkable fact that within a boundary embracing Sweden, Norway, Denmark, Germany, Austria, Switzerland, Holland, Belgium and Great Britain, are included 3,870,000 of the 4,880,000 telephones in Europe, giving a ratio of one telephone to every 35 inhabitants. The Latin countries account for only about 610,000 of the total number of telephones, and other states for about 400,000. Whether the striking difference in the development of the Latin States and those which are mainly Teutonic either by race or speech is due to language, temperament, or latitude, is a problem of which there is no obvious solution.

Great Britain has increased from 774,300 in 1913 to 911,937. London has 311,350 stations; Glasgow 40,936; Liverpool 38,493; Manchester 37,748; Birmingham 24,528; and Edinburgh 17,224. Twelve cities in all have over 10,000 telephones each.

A feature of the telephonic development of Asia is that the further east one goes the more telephones one finds. Japan has over 309,000; China and Hong Kong about 33,000; Dutch Indies 32,000, and India 30,000, while in Persia, Arabia and Turkey in Asia the telephone is practically non existent.

There are nearly 13½ million telephones in North America and 724,490 in Canada. New York has 761,940 telephones, Chicago 504,428, London 311,350, Boston (Mass.) 246,594, Berlin 187,982, and Paris 149,050.

Penarth E.L. Co.—The total revenue was £14,990, dividends of 7 and 7½ per cent. respectively were paid on the preference and ordinary shares and a sum of £2,331 carried forward.

The Overstrand Hotel.—This pleasant hotel on the cliffs just outside Cromer contains a considerable amount of electrical plant and fittings. From a leaflet issued by the G.E.C. we learn that the necessary electricity is generated in a large apartment at the side of the garage. The "Witton" generator, rated at 7-10 kw., 100/140 volts, 900 r.p.m. is belt-driven by an 18 h.p. Hornsby oil engine, and the storage battery comprises 53 21-plate cells having a capacity of 600 amp-hrs. The switchboard is fitted with a "Salford" automatic battery cut-in and cut-out, and the usual accessories. The lift, which was installed by the Express Lift Co., Ltd., of Westminster, serves six floors and can raise a load of 7½ cwt. at a normal speed of 150 ft. per minute, and following the usual practice in such cases is compound wound. It is rated at 6-9 h.p. The semi-indirect system of lighting was largely adopted, the majority of the fittings being equipped with "Equiluxo" ornamental glassware.

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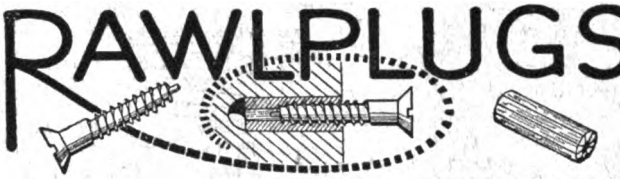
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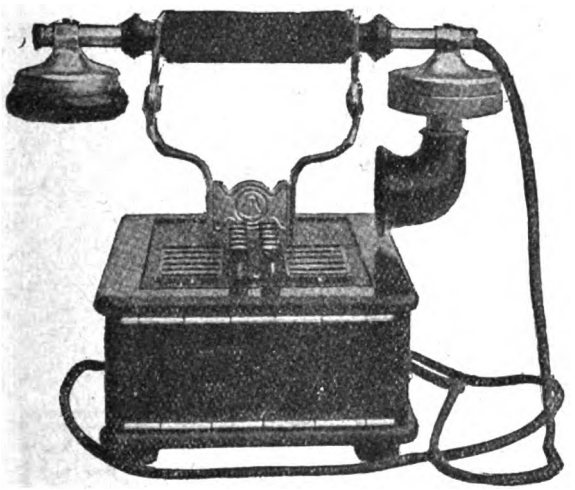
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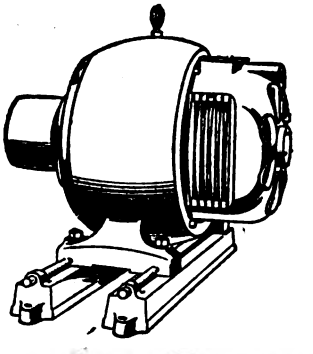
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application.

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All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Overhead Lines and the Post Office Dictatorship.

In an editorial on the subject of overhead power lines in this country my Chicago contemporary, the *Elecrical Review*, comments on the unique and dominant position occupied by H.M. Postmaster-General in the matter of running overhead lines, and preventing others from doing likewise. As has been pointed out in another contemporary nearer home, the P.M.G. not only has control of the telegraphs and telephones, but is also granted powers which to the onlooker appear somewhat unreasonable. It is pointed out that not only does the General Post Office formulate rules and regulations which are sometimes contrary to technical accuracy and reasonableness, but that there is apparently no appeal in respect to their application to anyone but the P.M.G., who is thus called upon to interpret rules he himself has made, and who is not likely to be entirely unbiased in his judgment where the interests of his own Department are concerned.

We are admittedly backward in this country in the development of overhead power distribution, and the Parliamentary position, as regulated by the Board of Trade, coupled with the monopolistic powers of the P.M.G. above referred to, are doubtless responsible to a considerable extent for arresting healthy development along those lines. It is far cheaper to run a pole line through suitable areas than underground cable, and, moreover, there is less disturbance of the ground, and consequent obstruction of traffic, with its attendant irritation and effect upon road surfaces. Pole lines are quite common in the States, and, as it is generally the onlooker who sees most of the faults in the other man's game, we might profitably act on the hint conveyed in our contemporary's pages.

When one comes to realise it to the full, the Postmaster-General is an autocrat in the matter of stringing electrical conductors on poles or between buildings above ground, however his powers may be restricted where underground cables are concerned. The powers of the P.M.G. date back to early days, when the telegraphs were the primary consideration and electric lighting had not been seriously considered as a practical proposition. With the introduction and expansion of electricity supply the State saw danger ahead, and duly filed its monopolistic clauses, which in effect render the P.M.G. an overlord of the air so far as electrical conductors are concerned. The prevailing principle is telegraphs and telephones first, then, so long as you don't encroach or set up electrical disturbances in the vicinity, you are graciously permitted to run your power wires through the same atmosphere, if necessary a mile or more away from Lawyer Brown's telephone circuit.

Although the necessity for safeguarding the interests of telephone users, as well as of the telegraphs, as a means of national intercommunication is fully realised, and every reasonable being is alive to the desirability of technical safeguards in this connection, the sense of proportion would appear grievously distorted when the interests of these two services take precedence over the vital claims of light and power upon which the whole country depends for its livelihood. Well may the Americans laugh at our antiquated laws, which make it a penal offence to set up a pole in the back yard and supply juice to the man over the way without asking leave of the P.M.G. and fulfilling a whole quota of abstruse and irritating regulations, framed in the sole interest of the telephone subscriber.

Nor does the 1919 Electricity Supply Act neglect to support this out-of-date principle, in spite of the prolonged adverse criticisms of obstructive Board of Trade regulations. Judging by the wording of Paragraph I., Section 22, of the new Act, the running of overhead wires is not permitted over land covered by buildings or used as a garden or pleasure ground. Bearing in mind the small gardens and winding lanes of rural England, it follows that if many private owners object to the crossing of their gardens, houses, or barns, overhead lines in this country, if constructed at all, will be in the nature of a jig-saw puzzle rather than engineering structures of reasonable and economic design.

The Telephone Service and Private Installations.

There is another monopoly possessed by the Postmaster-General which would appear also to exemplify the fable of the dog in the manger. Although the Post Office possesses rights in the matter of installing a system of internal telephones for any of its subscribers who desire such a system, and of connecting such a system with the public exchange, so that intercommunication service is available, it does not accord the privilege to those who care to install their own telephone systems to connect such installations to the public service. Although certain technical standards would have to be complied with in order that the general standard of public telephone intercommunica-

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tion be not lowered in efficiency, it is difficult to understand the principle of splendid isolation thus created and maintained, and more particularly in the light of recent rate increases for telephone service.

The telephone is a public utility service, just as much as electricity, gas, or water supply, and if I care to wire my house for electric light, lay water pipes, or run gas mains through my premises, there is nothing to prevent my obtaining a supply of each of these commodities, always provided my installation meets the technical requirements and is up to or superior to the standards laid down by the various supply authorities concerned. Following the same logical reasoning, if I install a telephone switchboard and telephones, with due provision for interswitching with the existing local Post Office exchange, if my lines have the requisite insulation, and the transmission efficiency of my instruments is equal to or better than the Department's standard; furthermore, if I grant the Post Office representatives reasonable access to my telephone installation to see that their standards are maintained, what logical reason can be advanced for refusing me the physical connection and interswitching facilities referred to?

If the State is unable or unwilling to develop the public telephone service on energetic lines, and if, as would appear to be the case, its methods are too costly for such development, it is surely better to allow private enterprise sufficient scope to assist in this development by granting intercommunication facilities in those cases where a large and enterprising telephone user elects to install his own private system. As matters stand at present, many large businesses find it necessary in their own interests to keep two systems going—one internal, for telephonic intercommunication between the various internal departments, and another private branch exchange, installed and maintained by the Post Office, for purely external traffic with the public service. The existence of such a state of affairs and its obvious absurdity sufficiently justifies this criticism, and it remains for a strong and far-seeing P.M.G. to clear the way for private enterprise and what would undoubtedly follow—profitable telephone development both for the individual and for the State.

ELEKTRON.

ATMOSPHERIC ELECTRICITY AS A SOURCE OF ENERGY.

M. Hermann Plauson, on the basis of recently conducted experiments, referred to in the *Schweizerische Chemiker-Zeitung*, is of opinion that an inexpensive and unlimited supply of electrical energy may be obtained from the atmosphere. He has published a book on the subject, entitled *Gewinnung und Verwertung der Atmosphärischen Elektrizität* (Extraction and Utilisation of Atmospheric Electricity), published by Boysen and Maasch, Hamburg, 1920. As antenna he uses a captive balloon having a metallic cover provided with a large number of pointed projections or spikes, and allows it to ascend to a height of 1,000 or 1,600 ft. above ground.

Positive electricity is then collected from the air and transmitted to the ground through a wire rope fitted with sparking gap, which in turn produces an electric vibration in a circuit. Electro-magnetic waves are also produced in an additional circuit by resonance, and can be utilised to drive a specially designed resonance motor. By inserting condensers and sparking gaps the efficiency and safety against lightning are increased.

M. Plauson obtained with one balloon at a height of 1,000 ft. a supply of 17.28 kw. hrs. per diem, and with two balloons 81.6 kw. hrs. He calculates that a battery of 10 balloons should give an annual supply of 210,000 kw. hrs. The distribution of such installations throughout the country would permit an unlimited source of energy to be tapped. —*Technical Review.*

UNDERGROUND HAULAGE BELLS AND TELEPHONES: TROUBLES AND THEIR REMEDIES.*

BY J. S. KENDAL.

(*Concluded from page* 370.)

TELEPHONE TROUBLES.

The most frequent causes of trouble on underground telephone systems appear to be those due to faults on the lines and to broken receiver cords where such are used. Underground telephones wherever practicable should be worked on a completely insulated system with two lines throughout; by this means much trouble due to cross-talk and noises will be avoided and earth returns are very unreliable. On a long haulage road equipped with signal bells it is often found that when the bells are in use it is practically impossible to use the telephones owing to the noise in the receivers caused by the induced effect of the disturbing currents in the signal lines which run parallel to the telephone lines. This induced effect has often been made use of to enable a man to tell when a distant bell was ringing, but the efficient working of the telephone system is of greater consideration than this minor detail. The trouble may be greatly reduced by the transposition of the telephone lines at all stations, junctions and similar places, changing the right-hand line over to the left side and *vice versa*. All wiring connections from the instruments to the lines should also be twisted and if thoroughly carried out good results and freedom from noise may be obtained.

Whilst discussing the effect of signal bells on telephones it may be useful to consider the effect in the opposite direction. Almost any trembling bell will ring well with the current from a magneto generator, so that in a system using a common return, should the telephone and bell "line wires" become crossed at any point false signals may be obtained on the haulage bells, possibly with serious results. Where such lines run side by side, as they do in nearly all cases, they should be kept tight, well supported, and wide apart is practicable in order to lessen their liability to become crossed or twisted together.

With regard to receiver cords, their use is being abolished in modern mining telephones, but on instruments where they are used good results are obtained by the adoption of three-core tough rubber or cab-tyre flexible cable, the third wire being used as a strain cord in ordinary use or as a spare wire in an emergency until such time as a new cord can be fitted. It often happens, however, that when a cord fails the whole of the wires are broken. The ends of the wires should be formed into an eye and soldered, as this provides a better fixing surface for the screws and obviates loose connections and frayed wire ends. Broken cords are very often the result of careless handling by persons using the telephones, and cases are common where the receiver is allowed to hang loose from the instrument instead of being hung up. The use of small flexible metallic tubing minimises these breakages but often makes the equipment awkward to handle.

Whilst discussing the treatment of mining telephones a case may be quoted in which a boy was found using a receiver as a hammer to drive his lamp nail into timber. This receiver luckily was in the form of a stout brass casting having the magnet coils run in solid with insulating compound and it is a tribute to its robust construction to

*Paper read December 18, 1920, before the North of England Branch of the Association of Mining Electrical Engineers.

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say that it was no worse after its severe treatment. In another case a telephone which refused to work was found on examination to contain some six-inch nails, evidently placed there for security by the lad who attended that particular station.

It is now a common practice on long underground haulage roads to install magneto telephones at all important points, operating them on a bridging system and having a set of code signals for calling, with different numbers or combinations of rings for each station. Trouble is sometimes experienced on these systems by the buckling of receiver diaphragms caused by a station ringing up whilst two other stations are conversing or perhaps by listening in when they are not required. Where this trouble is frequent it should be a rule that before ringing a person should lift his receiver to enable him to know if the lines are already engaged; or, if someone should happen to ring up whilst he is speaking, he should immediately hang up his receiver until the ringing is completed. Bridging systems should not extend beyond say ten stations if it is convenient so to arrange them, as with a lot of stations on the line annoyance and inconvenience is sure to arise. Long endless haulage systems suffer mostly in this respect because if there is a stoppage at any part of the road everyone makes it his business to inquire the reason.

Apart from this consideration the bridging system is very convenient for intercommunication purposes; it does away with the necessity for plug-boards and enables one station to call any other on the system without the use of separate connecting lines which would be almost impossible to install in underground roadways unless provided for by a multi-core cable. The instruments for such systems should have large magneto generators and long-coil polarised bells of not less than 1,000 ohms resistance. On systems of more than ten stations the bells used should have a greatly increased resistance, say 5,000 ohms, as with two stations speaking all the other bells are connected as shunts and, if of comparatively low resistance, their combined resistance will be very small and will greatly reduce the effect of the speaking current in the two instruments in use.

The reasoning of this statement may be better shown by an example. Suppose we have ten magneto telephones connected on a bridge system, each having 1,000 ohm bells. Then when two stations are speaking we have the other eight connected as shunts with a combined effective resistance of only 125 ohms. Now with the same number of instruments equipped with 5,000 ohm bells the eight in shunt give a total resistance of 625 ohms. The loss in speaking efficiency is therefore five times greater with the first arrangement, assuming the line resistance and other conditions to be the same in each case. For the same reason the induction coils of these instruments should have secondary windings of 100 to 150 ohms, which gives a better sending efficiency than the usual standard induction coil of 25 ohms.

Telephone transmitters do not usually give much trouble provided they are kept clean and free from moisture, which is sometimes not an easy matter. A transmitter which gives good results is the solid-back type, which is of substantial construction, easily cleaned, and free from liability to packing of the granules.

Speaking batteries should be of a type which will require little supervision. Good results are obtained from Leclanche cells, but the usual practice is to use dry cells for the speaking circuits, with the exception of for hot districts where they become too dry to be of any use. Such dry batteries should be carefully chosen, as some types are of no use for this class of work, being easily affected by dampness, or of too high resistance. The average life of a good dry cell on mining telephone work is about twelve to fifteen months, but they should be changed when their voltage on open circuit falls below 0.9 or 1.0 volt. In some instances it is advisable to use two dry cells in each instrument but in most cases good results are obtained by the use of one only. With P.O. standard receivers trouble was experienced with broken screw-threads on the moulded insulation of the ear-caps but this was overcome by substituting a similar shaped cap moulded upon a threaded brass ring which allowed the cap to be tightened without stripping the threads.

Where an exchange system is required the lines from separate stations may be run to a convenient centre provided with an annunciator board and plugs, each line having an indicator and plug receptacle, communication being established by connecting cords and plugs. For underground work, however, this type of board usually gives trouble with broken or short-circuited cords and plugs and also with dirt in the jacks. The single-cord board is the worse defaulter in this respect, having a cord and plug for each line, the failure of which cuts that line out of use until repaired by an electrician. With the separate-cord board communication between stations is made by a double-line cord having a plug at either end, and stoppages due to faulty cords or plugs may be reduced by keeping at hand one or more spare cords. A type of board which does away with cord trouble altogether is that known as the cordless board, which only necessitates the insertion of a two-ringed plug in a jack, or the moving of a switch. For small exchanges, say up to six line, this type will give good service, but for larger boards the separate-cord type is recommended, as the cordless type becomes unwieldy and confusing above this size. Where any station is required to communicate with two separate systems it is usually better and cheaper to provide a two-way switch and extension bell rather than a two-way plug board.

Appended is a summary of telephone faults covering a period of eighteen months:—

A Record of Faults occurring on Underground Haulage Telephone Systems during a period of eighteen months.

Monthly period—	No. of faults. 1st.	2nd.	3rd.	Per cent. per Instrument. 1st.	2nd.	3rd.
Lines on Roadways—						
Broken	1	3	1 ...	3.1	4.8	1.9
Earthed	1	0	6 ...	3.1	0	11.3
Crossed or twisted	4	7	6 ...	12.5	11.3	11.3
External wiring	0	0	1 ...	—	—	—
Internal wiring	1	1	3 ...	3.1	1.6	5.6
Earthed instruments ...	1	0	1 ...	3.1	0	1.9
Magnetos and cut-out gear	4	4	3 ...	12.5	6.4	5.6
Switch hooks and springs	1	5	5 ...	3.1	8.0	9.4
Loose connections ...	0	2	2 ...	0	3.2	3.7
Damaged receivers and ear-caps	2	6	4 ...	6.2	9.7	7.5
Broken receiver cords ...	11	24	15 ...	34.3	38.7	28.2
Dry cells	3	5	1 ...	9.3	8.0	1.9
Transmitters	1	4	0 ...	3.1	6.4	0
Bells	0	0	2 ...	—	—	—
Switches	2	0	0 ...	—	—	—
Dampness	0	0	1 ...	—	—	—
Miscellaneous	0	1	2 ...	—	—	—
Total number of faults	32	62	53 ...	—	—	—
Average number of telephones in use ...	10	16	18 ...	—	—	—
Average number of faults per telephone per annum				6.4	7.7	5.9

As showing the difference in working results, a record of faults on seven similar telephones installed in engine rooms, etc., only gave a total of six minor troubles for the whole eighteen months, probably due to the difference in service conditions.

The approximate length of single line wire in use for the bells and telephones on these systems were respectively 23,000, 25,000 and 30,500 yards for the stated periods. Taking into consideration all troubles on the lines, including falls, timbering, etc., this gives an average number of faults per thousand yards of 2.34, 1.92, and 1.86 for the respective periods, the last figure being a reduction of 20 per cent. on the first.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 121.

Can any reader give me full details of the use and operation of the Tesla coil?—J.E.H.

QUESTION NO. 122.

Please can any reader give me full details of checking the ratios of various transformer connections, preferably "Scott," "Zig-zag," etc.?—J.E.H.

(*Replies to Questions Nos. 121 and 122 must be received not later than July 30, 1921.*)

THE EDUCATION OF THE APPRENTICE.*

BY J. MARSHALL BELL.

While considering the education of the apprentice as a special case it is the writer's intention to deal with education in a general sense. If it be considered that this subject is too academic for an engineering society, it may be pointed out that when the mining electrical engineer wishes to get the best possible result from the plant he specifies certain standards of performance and material. It is, similarly, quite in order and necessary for us, as practical men who have to deal with the boys when they leave school, to ask the question:—Are they as well educated for our purpose as they might be? There is naturally a very great difference between testing, say, an electric motor and an embryo apprentice. The motor can be put through certain recognised tests as to efficiency, temperature, rise, etc., but the testing of the suitability of a boy for any particular occupation, so far at least, cannot be reduced to a few simple observations and to numerical calculation. It must not be assumed, however, that much more exact tests of a person's capabilities will not some day be devised, and then reduced to a scientific basis. Some work has already been done in this direction, but this will be touched on later.

In a recent article on Scottish Education termed "Teacher Indicted," it was stated that: "The average boy or girl who leaves school to-day is less shrewd, less well founded, less mentally and morally well balanced, and, most important of all, less avid for further knowledge and less able to turn the experiences of life to substantial account than were his parents, and still more his grandparents, at a similar stage of their lives." The blame of this state of affairs was laid on "ill-advised and untimely experiments" and on the present-day teachers, who, indeed, were described as "merely the blind leading the blind."

It was said of the teachers that: "They have, in the fine old word, no 'call' to teaching, and teachers are born, not made," and the question was asked: "Let the employers speak: are they getting better and brighter apprentices? No!"

While the writer of the present paper does not think that the charges in the articles referred to (and they were numerous and severe ones) were wholly unjustified, it might be said for the teachers that they are themselves the product of, and are bound to work under, the present system of education, which, to say the least, is very far from perfection.

But our question now must be, not who is to blame, but what can we do to help? It is our duty to specify what we really require, with the strong probability that a definite demand, long enough sustained, will result in a future supply.

It seems to the writer that the last century, while undoubtedly one of great progress in material things, has been too one-sided in development and that it has been forgotten that, as Pope wrote two hundred years ago, "The proper study of mankind is man."

At the present time it seems to be dawning on mankind in general that material advancement is, not completely satisfactory in itself, and the sense of something lacking is probably at the bottom of the present world-wide unrest, and though the pursuit of the majority is still after material prosperity the need is in itself mental.

It may be that the present century will witness a great reaction, and that men will turn more to the study of the mind and body of man in all its different aspects, and particularly to the study of practical psychology with its applications in the education of the young and in everyday life. We must all consider education; it is part of our lives, and cannot be separated from it.

In a broad sense it begins at birth, and only ends, as far as we know, at death, but in the more restricted sense it may be defined as systematic training by others. What we are doing in effect in education is to say to the pupils: We, who have gone before you, have found from experience that the best way of doing certain things in life is in such and such a way. That is, education is a deliberate passing on of accumulated experience, and consequently it must expand and change from generation to generation if progress is to continue.

Now we educate mind and body, but mainly mind, and at this stage we must ask what is meant by this. It is no part of this paper to inquire where mind comes from or where it goes, nor can it be clearly defined at all. All we know is that it is a unity expressing itself through the brain and body.

The body is the machine, the brain is the switchboard, and the mind controls the body through the brain. The mind is no use unless the body is more or less intact, just as a switchboard attendant would be helpless to supply power from a wrecked turbine; but as an attendant can often remedy a minor defect without shutting down, so can the mind control the body to a much greater extent than the body can affect the mind. Our personality distinguishes us from any other person, however similar we may be in weight, chemical composition, and other material properties. We are ourselves, therefore, because of our minds. Beyond our conscious mind there seems to be a much greater part, and a better part in every way—the sub-conscious mind. This appears to be the storehouse of thought and impressions, and the melting pot in which new ideas are formed before they rise and become conscious thoughts. Admittedly, no one can explain the ultimate process by which our mind receives impressions and translates them into thoughts which may become actions ultimately, any more than we can give a real explanation of anything in the material world.

We use electricity, but however complicated the apparatus may be in mechanical construction we only know that when we arrange the materials in a certain way we obtain certain results, without knowing why. So with the mind. If we can impress it in some manner to obtain some particular effect, it is as much as we need or will ever know. Constant repetition of an idea, for example, by a teacher to

*Paper read December 17 before the East of Scotland Branch of the Association of Mining Electrical Engineers.

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a child results in a child accepting the idea as a fact, even though it may be really untrue in itself.

Again, any fact very strongly impressed on anyone's mind, though the impression itself may be of short duration, remains with us always, as shown in the proverb, "Burnt bairns dread the fire." We can all remember certain incidents of our childhood, painful and pleasant, because they happened to be strongly impressed on us at the time. Now these impressions reached our mind by way of our senses, and all our knowledge is made up of what we have seen, heard, and felt. When we educate we use knowledge as an instrument, and reach the mind through the senses. Knowledge, however, is the raw material which the mind has to deal with, and all progress arises from some mind turning its raw material into some new form.

This faculty of so dealing with knowledge we call originality, and while possessed by most minds in some degree, distinctive originality is admittedly a rare quality, but one of which the world now, as always, is in great need of. It cannot be taught, but can only be attained by allowing each mind to develop itself in its natural direction.

Perhaps this is one of the main defects of modern education—an apparent attempt to turn out all scholars on the same plan—an idea of a very primitive type. We see a reaction against this in the "Montessori Method," which has the underlying idea of allowing each child to learn by doing, and more or less to go as it pleases.

The middle course is perhaps the best—that is, a general type of education for most of the time, and the remainder spent in allowing each scholar to develop, on individual lines, any particular capabilities that he may possess. Expense makes impossible a real individual training for all, but students can be grouped according to common interests to a greater extent than is now done.

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

WIRELESS TELEGRAPHY. By B. Leggett. 485 pp., 230 figs. (Chapman and Hall. 30s. net.)—This book justifies most fully its inclusion in the Directly Useful Series, for it is the only volume in English which deals in detail with quenched spark systems (including the original Telefunken system), and in addition it includes much matter which has never hitherto been published in any country. The importance of the system dealt with and the size of the work will come as a surprise to most readers, who will be correspondingly well-advised to study this book, because the quenched spark system has been employed in almost every country, is adopted extensively in the United States, Australia, Japan, China, and Germany, and can indeed for land stations claim to rank with the Marconi system in importance. The quenched spark system can be regarded as an international system, and a number of well-known shipping lines are fitting new vessels therewith. The author is well qualified to write upon the subject since he has had experience in the manufacture, installation and operation of most of the apparatus which he describes. After an introductory chapter and a consideration of the theory of wireless transmitters, with special reference to quenching, the author deals exhaustively with transmitting and receiving apparatus and their accessories. Chapters are next devoted to the intensification of weak signals and to special apparatus for transmitting and receiving circuits, after which there is a series of important chapters dealing respectively with wireless telegraphy upon ships, with land stations, with military wireless telegraphy, and with wireless telegraphy in aviation. The chapter on continuous wave telegraphy and telephony is up-to-date, and will be generally appreciated, and a good general conception of the propagation of electro-magnetic waves—not quite academically correct in all its details, but clear and quite sufficient for practical purposes—is to be obtained from the concluding chapter. In the chapter on the maintenance and operation of wireless apparatus the author goes considerably outside the field of wireless telegraphy itself, but the practical operator will be glad to have in the one book hints upon maintenance for which he might reasonably expect to have to go to another volume.

In order to prevent misconception it must be explained that this book deals with other systems than the quenched spark system—including the Marconi system and continuous wave systems—but its special feature is the exhaustive treatment of the quenched spark system now dealt with for the first time in the English language. A good feature of the book is the large number of excellent illustrations. In particular there is a line diagram of component parts and electrical connections set alongside the photograph of every important piece of apparatus. This is a feature of the greatest possible assistance to the reader, and the only further improvement which we can suggest is that the photographs might have been lettered to correspond with the line diagrams where possible. This book does indeed fill a distinct gap in wireless literature and we have no hesitation in recommending it to our readers.

ELECTRICAL TRANSMISSION OF PHOTOGRAPHS. By Marcus J. Martin. 136 pp., 73 figs. (Pitman, 6s. net.)—When perfected, the science of photo-telegraphy will be of assistance as an aid to the police in the detection of criminals, as photographs of the "wanted" men could be telegraphed to ports and towns at home and abroad. It should also be valuable for military purposes in time of war, and has already been used for journalistic purposes. In fact, the apparatus has been worked out to give more or less successful results, but much research on detail is still waiting to be carried out; therefore the chapter in this book devoted to full details for the construction of a machine for transmitting and receiving should be of help to those who are interested in experimenting with a view to effecting improvements. A full history of the subject is given right up to the present time, when the transmission of photographs by "wireless" is receiving some attention. Some of the subject matter originally appeared in the columns of our contemporary, *The Model Engineer*, and here appears in an amplified form, rendering the book one of considerable fascination.

THE DYNAMICAL THEORY OF GASES. By J. H. Jeans. 442 pp., 26 figs. (Cambridge University Press. 30s. net.)—All classes of physicists should obtain the latest edition of this important work, which originally set out to develop the theory of gases upon as exact a mathematical basis as possible and which has since been modified so as to make a considerable portion of the book intelligible to the non-mathematical reader. The volume is so arranged that the non-mathematical reader can get a good grasp of the subject by studying the physical chapters alone. It will be found that the third edition differs from its predecessor mainly in the greater prominence given to the quantum theory. The matter in the earlier edition on this subject has been partially rewritten and a new chapter has been added on quantum dynamics, and it is hoped that this will help to stimulate the interest of English-speaking readers in a branch of science the development of which has so far been left mainly to other nations.

The author develops first the mathematical theory of a gas in a steady state and considers then its physical properties. The mathematical theory and physical phenomena of a gas not in a steady state are then considered in the same way. The final section is devoted to radiation and the quantum theory. Whilst it is only fair to say that this book as a whole must be regarded as an advanced text-book appealing primarily to those who have good mathematical knowledge, it should also be stated that the physical chapters afford very fascinating reading and are quite intelligible to anyone who has a good general knowledge of physics.

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Various Items.

Service Notes.—Recruiting for the electrical departments of the Army and Navy is improving. Good mechanics and wireless men can find employment in the Royal Air Service.

Removal.—Mr. Alfred S. E. Ackermann, B.Sc. (Engineering), London, has removed to 17, Victoria Street, Westminster. His telephone number is 244 Victoria, as heretofore.

Blackburn Rovers.—Mr. H. Garstang, electrician and electrical contractor, has been re-elected a director of the Blackburn Rovers F.C. in the English League.

Stirling.—The T.C. is applying for sanction to borrow £4,000 for two generating sets and £3,700 for building operations. A 300 kw. set is also being purchased from Hereford for £2,000.

Mexico.—The question of improved communication is being carefully studied by the Government, the existing wireless stations are to be improved and new ones, at first in the Northern cities, established.

Malaysia.—It is hoped that ultimately generating stations will be erected near Taiping, Ipoh, Kuala Lumpur and Serembar. Each town is to have its own station, but will be connected with Kuala Lumpur for emergency loads.

American Chamber of Commerce in London.—The Year Book for 1921, which can be obtained from 8, Waterloo Place, Pall Mall, S.W.1, for 5s., is replete with all information concerning buying, selling, appointment of agents, the securing of agencies, etc. It is very conveniently arranged.

3s. 9d. Above the Average.—The cost of charging the electrical vehicles at Swansea is 7s. 9d. per day. The average, it is stated, throughout the country is 4s. The reason of the 3s. 9d. extra is in consequence of special charging apparatus not having arrived.

Federated Malay States.—The Government is taking steps for the rapid development of the country, particularly as regards town planning, irrigation, sewage disposal, and the provision of electric light and power in the larger towns. Particulars from the Malay States Information Agency (88, Cannon Street, E.C.4).

Manchester Electro-Harmonic Society.—The concerts will be resumed on the last Friday in October next, and continued on the last Fridays in November, December, January, February and March in the Marble Hall, Albion Hotel, Piccadilly, Manchester. Hon. Mus. Director, Mr. W. J. Smith; Hon. Sec., Mr. J. Hill, 24, Brazenose Street, Manchester.

Burnley.—Industrial disputes have made it unlikely that the additional plant will be completed in time for the winter load. The Committee have therefore decided not to sanction further extensions of mains for the present. The scale of charges has also been revised. An increase of ·33d. has been made on the power scale; ·2d. on traction charges, and ·5d. for lighting.

The Boy Scouts' Shilling Fund.—A considerable sum is still required to "carry on" and put the Boy Scout movement on a sound footing. To this end the Shilling Fund is to be continued till November, and receipt books for 20 shillings will be sent to those who would like to collect by the Hon. Organiser and Sec., Mr. E. R. B. Graham (Messrs. Tredegars, Ltd., 5, 7, 9, Brook Street, W.1), or individual shillings may be sent to the offices of ELECTRICITY (36, Maiden Lane, W.C.2).

Boy Electrocuted at New Tredegar.—A ten-year-old boy, named Frederick E. Harwood, was recently electrocuted while bird-nesting near an engine-house of the Tredegar pits. It appears that his foot became entangled with a 3,000-volt overhead wire. We are not in possession of all details, but that it was avoidable would seem evident from the fact that at the inquest the engineer responsible undertook to carry out precautionary measures with a view to preventing similar accidents in future.

G.N. Telegr. Co., Ltd.—One Franco-Danish, one Anglo-Danish, as well as the cable between Petrograd and Libau, are still interrupted, the mine-fields at points of interruption not yet having been cleared. In the report for 1920, the directors state that the traffic over the cables in Europe and the Far East has been satisfactory. Latterly the European traffic has decreased some 30 per cent. compared with a year ago and is not likely to improve till the general trade revival sets in. Negotiations with Russia and Poland are far from satisfactory, and in any case there is not much chance of appreciable traffic for some time to come. Nevertheless a total dividend and bonus of 24 per cent. for the past year is proposed while £285,892, or £144,285 more than last year, is carried forward.

China.—Arrangements are being made by the U.S.A., Belgium and France to educate Chinese Students in Engineering on a large scale on account of the imminent big developments expected in China.

G.E.C. Sports.—The third annual sports of the G.E.C. and associated companies were held at the London County Ground, Herne Hill, on Saturday the 25th ult. The directors were represented by Mr. Hugo Hirst, Mr. and Mrs. Max Railing and Mr. S. D. White. The prizes were distributed by Mrs. Hirst. The military band provided music for dancing on the green until late in the evening. The chief honours were won by Witton Works, Fraser and Chalmers Engineering Works, and the Express Lift Co., Ltd.

Australia.—The Victorian Government Railways require 100 24-volt, 140 amp.-hr. and 32 24-volt, 200 amp.-hr. accumulator sets; 45 axle generator lighting equipment sets, 30 amp. size for passenger cars, 10 sets for vans, 16 sets 40 amp. for special cars; also 72 main car switches, chopper type or rotary type, and 2 extra battery change-over switches. Tenders by Aug. 31. Also required, tenders by Aug. 24 for one motor-generator set, 70 amp. and 80 volts, slate panel and various switches, etc., for automatic telephone exchange. The Queensland Water Supply department requires tenders by the 18th inst. for 54,000 yards copper cables, and 2,980 ft. lead-covered steel armoured cable and accessories. Full particulars from D.O.T., where specifications may be seen.

Trade Notes.

Simplex Conduits, Ltd., have issued a new priced leaflet, No. 885, dealing with conduits, fittings, etc.

A card blotter from **Keighley Gas and Oil Engine Co., Ltd.** (59-61, New Oxford Street, W.C.1), refers to the Company's gas, oil and spirit engines.

Woven net or cast grid types of "Cressall" controlled resistances for cranes, lifts, hoists, etc., are illustrated and described in list No. C.R. 1921, issued by the **Cressall Mfg. Co.** (40 and 41, Staniforth Street, Birmingham).

Bruce, Peebles and Co., Ltd. (Edinburgh), have nearly 80 lantern slides illustrating their A.C. and D.C. generators and motors, motor-generators, rotary converters, frequency changers, the Peebles-la-Cour motor converter, and the works.

Pocock Bros. (64-6, Newington Causeway, S.E.1), announce that they are in a position to supply leather gloves for those engaged in handling metals, leather aprons and rubber overboots for outdoor workers. Samples may be inspected.

We acknowledge receipt of the July issue of "Installation News" from **Simplex Conduits, Ltd.** (Garrison Lane, Birmingham). It contains several articles of a technical or semi-technical nature, including "Earthing of Factory and Works Installations," various specialities, and "Wiring in Modern Concrete Buildings." Many "authorised persons" would benefit from a careful perusal of the article on "Earthing."

Hightensite, Ltd. (Normandy Works, Custom House, E.), are issuing a neat booklet entitled "Improvements in Insulating Materials." The Company was formed in 1915 largely to relieve the acute shortage resulting from the withdrawal from the market of the German "Stabilit," and the works are now equipped with the most up-to-date plant for dealing with the various operations in the manufacture of ebonite and Hightensite in sheet, rod, tube, mouldings, linings and covered metals.

The British Electrical Development Assoc. (Hampden House, Kingsway, W.C.2) has just issued a publication entitled "Selective Publicity for Installation Contractors and Electricity Supply Undertakings," at the price of 2s. 6d. It is an effort to stimulate further enterprise on the part of contractors, etc., and contains 12 specimen letters and all the information necessary with regard to their reproduction and circulation amongst potential customers.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
JULY 15, 1921.

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CURRENT LIMITERS.

By E. H. Miller, A.M.I.E.E.

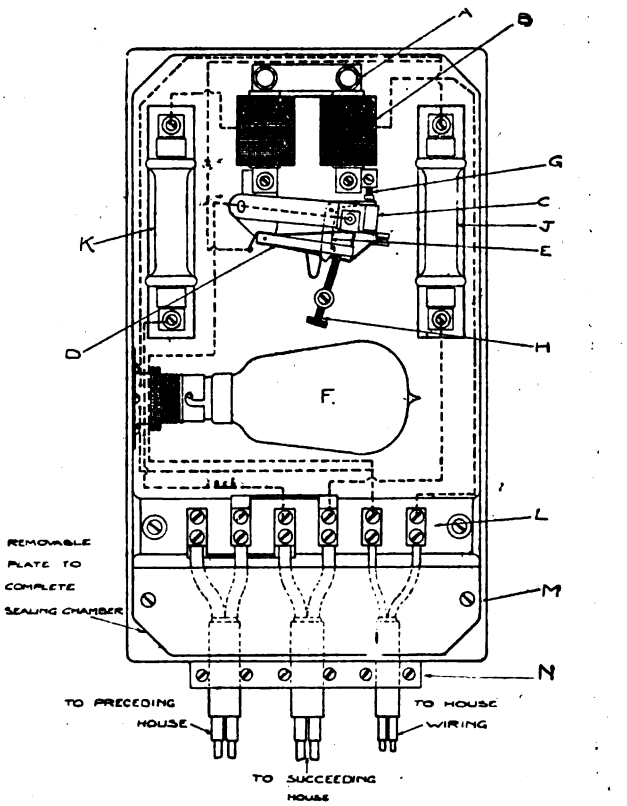
Current limiters are neither new nor untried devices, but so far, in the main, they have proved most unsatisfactory. Most of them work on the "flicker" principle, which has the effect of causing all the lights to blink more or less rapidly as soon as the pre-determined load has been exceeded. This is not only annoying to the consumer, but it also has a most vital objection from the Supply Authorities' point of view. Assuming, for instance, a system with the limiter set at 100 watts, and that a 300-watt electric iron is switched on. Under this condition experience has proved that the flickering becomes so rapid that the iron heats up almost as much with the limiter in circuit as without, and the iron can certainly be used for the purpose for which it is intended, whilst the rapid flickering has the effect of quickly ruining the limiter itself.

An attempt has been made in at least one type to overcome this trouble by entirely breaking the circuit in the limiter after a pre-determined time limit, but as this is not self-resetting and necessitates a visit from an employee of the Supply Authority, it discounts somewhat the chief advantage claimed for it.

Other types break circuit entirely when the pre-determined value of current is exceeded, but they also are not self-resetting. This necessitates a visit to the cellar (or wherever the limiter happens to be installed) in the darkness, and it is obvious that this type also does not find favour with consumers.

In the Ediswan current limiting device, an entirely different arrangement is adopted. The device embodies a special lamp resistance and when the predetermined amount of energy is exceeded the limiter operates and switches the lamp resistance in series with the load, thus dimming all the lamps on circuit. This does not annoy the consumer nearly so much as the flickering, or as total extinction, particularly as the switching off of the last lamp, even if it is of only 20 watts capacity, will immediately restore the rest of the lamps to full brilliancy. A further advantage to be noted is that if an electric iron be switched on, or even a 1 kw. radiator, the limiter will simply operate in the usual way and no more current can pass than the lamp resistance will allow. With a 100 watt setting, where the lamp resistance will pass only 80 watts on a short circuit, it will be seen that the current passed through an iron, for instance, will be insufficient even to warm it. A further advantage is that on mild short circuits the limiter sometimes operates without blowing the main fuses, but even in the case of bad shorts it tends to operate and provides an additional break, thus making the blowing of the fuses very much less destructive than would otherwise be the case.

As will be seen from the illustration, the limiter proper consists of a U-shaped laminated yoke (A), containing a main series coil (B) on each leg, and having a laminated armature (C) pivoted at one end below it. Below this laminated armature is pivoted a further arm of fibre (D), which is normally held to the main armature by a hooked member (E) catching into a pin in the fibre (D). The main armature (C) carries one contact and the fibre arm the other, and the contacts (which are provided with carbon breaks) normally short circuit the lamp resistance (F). When the pre-determined current is exceeded, the main armature (C) is attracted to the yoke (A), and carries with it the fibre arm (D) since they are hooked together. When the main armature (C) has completed its travel, however, one end of the hooked member (E) impinges on a stop



DIAGRAMATIC VIEW OF EDISWAN CURRENT LIMITER WITH COVER REMOVED, SHOWING CONNECTIONS.

screw (G), releasing the fibre arm (D), which consequently drops away, and thus relieves the short on the lamp resistance (F). This puts the latter in series with the load and dims all the lamps on circuit. Below the fibre arm (D) will be noted in the illustration a further stop screw (H), and this, together with the screw (G) previously referred to, are the only adjustments necessary. The adjustment, in fact, is exceedingly simple and can be carried out by practically inexperienced people quite readily.

It will further be noted that in addition to the limiting device proper, the case contains the lamp resistance (F), two single-pole fuses (J) and (K), a terminal board (L) (for connection on the loop-in system), and a sealing chamber (M) (for use where lead-covered paper cable is employed), in addition an earthing clamp (N) is supplied. Therefore, the case, which is exceedingly robust (being made of cast iron), contains absolutely all that is necessary in order to give service to a consumer. It is unnecessary for the Supply Authority to buy separately the limiter, the fuses, sealing chamber, etc., and to mount them all up on a separate board, and to inter-connect them.

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Of course, all Supply Authorities do not use the loop-in system, but at least one Corporation which uses this system in combination with the Ediswan limiting device state that they can by this means give service at one half pre-war cost. A result worthy of consideration in connection with Housing Schemes, thus ensuring a reasonable revenue from the small user sufficient to justify the capital outlay necessary to give him a supply.

FAULTS ON ECONOMISERS.

By H. S. B. ROBINSON.

Economisers, like boilers, require periodical examination so that any deterioration or other causes tending to lessen the efficiency of the apparatus may be discovered and remedied at once. Attention to this point often minimises expenditure in repairs and obviously ensures full benefit being obtained from the economiser. It is thought, therefore, that the following remarks may be of interest to those connected with electric light and power station work, where the load is variable and there is frequently a sudden call for extra power.

Condensation:—When an economiser is fed with cold water, condensation of the gases takes place on the bottom boxes and lower portions of vertical tubes, resulting in rapid external corrosion. The soot also becomes hard and prevents the scrapers working. A simple method of warming cold water and thus preventing any trouble is to connect a ½ in. wrought-iron pipe to the hot water outlet pipe from the economiser and the suction side of the feed pump, so that with each stroke of the latter a small quantity of hot water is drawn into the cold feed and the chill consequently taken off. In order to regulate the supply of hot water, a small tap should be fitted. Heating the boiler feed-water by means of an economiser is not only a direct advantage on account of the saving of fuel, but is also indirectly of great benefit to the boilers by preventing the damage from unequal expansion and contraction which always occurs when the feed is introduced cold. Sometimes this is overlooked.

Incrustation:—One of the principal difficulties which steam users have to contend with is the impure nature of the feed-water which, if not specially treated, proves highly detrimental to the boilers. Not only is the efficiency of the steam plant affected, but the free expansion and contraction caused by the variation in temperature is to a great extent prevented. In some cases a water softening apparatus is adopted for large boiler plants, but the more simple, less costly, and general method adopted is to introduce an anti-incrustation fluid into the feed-water before it enters the economiser. The greater part of the deposit is thus precipitated into the economiser, where it can be more easily removed and at less cost than from the boilers. A wrought-iron galvanised tank may be used for holding a supply of the anti-incrustation fluid, with a small injection pump fitted at the side and coupled direct to the economiser feed pipe. The tank may be placed in any convenient position in the engine or boiler house, and only requires a ½ in. rope for driving the pump. When boilers are fed with anti-incrustation composition, it is much more effective when introduced in small regular quantities with the feed-water, as the whole of the latter is then treated, instead of only a small proportion when it is placed in the boiler in bulk through the manhole at cleaning times.

Regulation:—It will sometimes be found that the cross shaft carrying clutch on the reversing motion is not running at full speed, probably due to grease coming into contact with chains and pulleys. This must be avoided if the necessary friction is to be maintained. The chains are always liable to stretch from time to time, and should be shortened immediately, otherwise the scrapers will not travel the full length of the tubes. When chains become worn, they should be turned round on the pulleys. The scrapers should be kept constantly running when economiser is in use. If they do not work freely, the set screw connecting chain pulley and worm wheel must be removed, after which they can be worked up and down the tubes by means of a handle on pulley spindle until running freely.

Accumulation:—To remove an accumulation of soot from the tubes it will be necessary to shut down and empty the economiser, the inlet and outlet feedpipes should afterwards be disconnected, all valves opened, and heat passed through the economiser chamber for several hours, keeping the scrapers constantly running meanwhile. It should be mentioned that before refilling the economiser with water, the tubes must be quite cool, an important item, which cannot be over-estimated. This method must not be resorted to oftener than can be avoided, in fact, if the soot pit is cleaned out every month, it is doubtful whether it would ever be necessary.

COAL AND OIL.

Although we have been able to keep up our transport services and maintain the supplies of electrical energy for public and private lighting, as well as a proportion for industrial power load, largely, but not entirely, by using oil fuel in the furnaces, it must not be supposed that oil can displace coal. It is very useful in an emergency, and provision should therefore be made for its availability on short notice for use in connection with all public services, but, except in isolated cases, it cannot be used continuously. Our greatest hope lies in the ultimate production of synthetic fuel, combined with the utilisation of all available water power.

The present coal *v.* oil position is clearly stated in an article by Sir Richard A. S. Redmayne in the June issue of the *British Science Guild Journal* as follows:—

"The war has emphasised one important point in respect of the fuel question as affecting Great Britain, and this is our dependence on outside sources for our supply of fuel oil. We frequently hear oil referred to as the great competitor of coal and of its substitution for coal in raising steam, more particularly in relation to marine and land transport. But oil cannot be a real menace to the coal trade, for the quantity of oil available is not nearly sufficient to meet the world's needs. About 800,000,000 tons of oil would be necessary to make the equivalent of coal now used, and the amount of oil available is only about one-sixteenth of this; and much of even this is now non-available for fuel as it is required as an illuminant, as a lubricant and for petrol. At the same time, price is a bar to its being used in many directions where coal is consumed. Oil, too, requires special arrangements for its storage, and if the storage tanks at a port are full, a tank steamer arriving there has no means of discharging its oil cargo. Oil also compares badly with coal in its comparatively small yield of valuable by-products.

"Coal, therefore, holds the field and must continue to do so. The problem in the future is how to make the best use of our coal supplies. To solve this problem satisfactorily we must apply all the resources of science to ascertain the procedure by which the maximum of economic advantages can be obtained from coal. The wealth that our coal is capable of yielding is far greater than that which is at present derived from it, and the difference represents a potentiality of increase in the national prosperity among all classes that is difficult to exaggerate.

"This subject is too vast to be dealt with fully here, but in the author's opinion the path of progress lies in the direction of the scientific carbonisation of our coal so as to secure the fullest possible recovery of by-products of economic importance which is consistent with a sufficient output of fuel to satisfy domestic and metallurgical needs, and of the utilisation of waste gases for the development of electrical energy. If this theoretical problem could be translated into a commercial possibility, the whole aspect of the fuel question would undergo an amazing transformation."

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THE EDUCATION OF THE APPRENTICE.*

BY J. MARSHALL BELL.

(*Continued from page 384.*)

Simplicity is much to be desired in education to-day. Certain subjects are essential, but let these be few, thorough, and simple in treatment. The three R's, as they are called, go a long way towards the general education necessary for good citizenship, which should be the minimum aim of all educational systems. Drawing of various types is a valuable training in many ways (for example, observation and memory), and cannot be left out. Some training in the principles of science, physics, chemistry, or geology, for example, should also be given. The reading and writing lessons can be made to include, in a general way, grammar, composition, history, geography, etc., without dividing these subjects into watertight compartments, which in too many cases would appear from their treatment to have no connection with one another. Arithmetic can lead on naturally to elementary mathematics.

Above all, let the educational aim be to encourage each scholar to observe and think for himself, and not to give a sort of diet of facts, which too often are merely boring and wearisome details, tending to kill the natural interest of the pupil. It must, however, always be remembered that school education is not an end in itself, and that the scholar is preparing for the battle of life and it is there his real education will begin.

If he has not been taught to see things for himself, and to think things out for himself, his success in life and value to the world will be so much less.

The use of the school to give the child's mind a bias towards any particular religious, political or social creed is to be deprecated. Still, the methods of suggestion could well be used to mould the child's character, as, for example, to inculcate into every scholar's mind that Right and Duty are as inseparable as positive and negative electricity, as long as he is encouraged to consider for himself what these mean. We hear a lot about rights nowadays but very little about the attendant duties.

At some point in a child's career the question of a choice of occupation must arise, and here we find a real need—the need being for a scientific method of choosing occupation.

There are many factors to consider, among these being the boy's capabilities and interests, the qualities needed for each occupation, and the question must also be asked—does the particular industry require recruits at the time? The results of school examinations give a prospective employer very little to go on, and on the other hand, the boy's teachers cannot well advise about an occupation when they know little or nothing as to what will be required of the boy when he enters it. About a year ago the writer had occasion to go over some 30 applications in reply to an advertisement for an apprentice mine surveyor. These came from all parts of Scotland, from Ross-shire to the Border counties and from East and West, and the ages of the applicants ranged from 14 to 23. A number even applied who were under the age and had not the certificates specified. The recent war had no doubt much to do with the high wages of some of the applicants, but the main point was that nearly every one had apparently very vague ideas of what would be required of them, and presumably every advertisement brings a similar crop.

Now there is surely room here for a better system of co-operation between school authorities and employers. Presumably it is within the power of the Education Authorities to establish a better system of recording a child's progress at school than by the Education Department Certificates only. A little has been done in this line by progressive teachers, but it will be a matter of years before any such system could be firmly established.

Tests of physical and mental qualities would require to be made periodically by the school authorities, resulting in a record something after this type—Boy, age 12. Physical tests—"Physique" normal, "Eyesight" normal. Not easily fatigued, etc., etc. Mental tests—"Observation" good for things seen out of doors; not so good for indoor objects. Poor for sounds. "Memory"—visual, good—auditory, poor. Rather imaginative and easily acted on by suggestion. Interested chiefly in drawing and natural sciences. Rather weak in arithmetic. Cannot concentrate on any subject for a long period, etc., etc.

This is not given as a complete or model record, but obviously a boy with this record would not be likely to make a good reporter or clerk, as his qualities and inclinations are more suitable to an outdoor life. He might for example, be a good field geologist in the making. Certain points require strengthening, concentration, for example, and his natural tastes allowed to develop. Why try to make a mathematician of him, or force him into an indoor occupation which for the time being offers a high rate of wages? It may be that at, say, 15, his qualifications will have altered considerably, but this does not diminish the value of a record. Psychologists have used tests in a limited way for a long time, and recruits for the Royal Air Force had more or less elaborate tests of nerve, quickness of reaction, etc., to go through; but to have any real value, the tests for each quality and stage of the pupil's career would have to be standardised and the record kept in, say, book form in duplicate, one for the pupil, and one for the school authorities.

If little work has been done on the above lines, even less has been done in considering what are the necessary qualifications for any particular industry. An association like the Mining Electrical Engineers, being representative of all phases of the mining industry, is a fit and proper body to deal with a question of this sort.

The writer hopes that a vigorous discussion will follow from the paper, for it is only those engaged in an occupation who know what is required from those about to enter it, and unless the requirements are clearly specified and made available to all interested, the demand for suitable recruits cannot well be met. There are many branches of the industry, each necessitating varying qualities, and it will take time to formulate the needs of each, but the need is great, as evinced by the present great interest in education. Assuming that we have got a suitable boy for, say, an apprentice electrical engineer, here again a general training is required with a further branching into more specialised work at a future date. It might be that of an armature-winder, or a designer depending on qualifications and interests. Practical work forms the real education in every occupation, and technical schools can only guide and deal with broad principles and attendance; these ought to run concurrently with the workshop training as much as possible.

If the school education has been efficient, a boy at 15 or 16 should be able to express himself fairly clearly in writing, he should have a sound knowledge of arithmetic and elementary mathematics, and be able to take up an article or book on a subject he is interested in and read it without skimming it over like a magazine story. At the same time he should know something at least about drawing to scale and be able to make intelligible hand sketches of simple objects and of apparatus he has come across in his science lessons.

The author does not deny the value of a classical education and a knowledge of modern languages for certain occupations, but often the time spent on them leads to a cutting down of essential subjects.

Languages may be a good mental training and help in the attainment of what is termed "culture," but for the immediate purpose we are considering languages might well be left out. On the other hand, it is inadvisable to make education too narrowly practical, for even when a boy leaves school he may not have discovered his real

*Paper read December 17 before the East of Scotland Branch of the Association of Mining Electrical Engineers.

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interests. During his school days he should be encouraged to consider for himself where his interests lie. It cannot be too strongly insisted that deep interest in an occupation is necessary for real success. In fact, our most successful men are "artists" in their own line. During some 13 years' experience of evening class teaching the writer has formed the opinion that the main obstacle in the way of the average student's success is lack of the power to concentrate on their studies over a series of years. Many turn up year after year, attend a few weeks, and drop off. Others attend perhaps a session or two and then quit, only to appear again a few years later. Those who allow no break to intervene between their school days and who attend session after session at the continuation classes, until attaining the necessary age for the particular examination they have in view, should have little fear of gaining the coveted certificate.

The definition of a practical man as "one who practises the—errors of his forefathers," fortunately applies to few nowadays, as most people recognise that the narrowly practical mood which despises "theory" is an untenable one. On the other hand we have the indefensible attitude of (if memory serves) the Cambridge professor who gave the toast "Here's to pure mathematics and may it never be of the slightest use to anyone," for it is a fact that nearly all seemingly useless theoretical discoveries eventually find a practical application.

There are men of action, men of feeling, and men of thought, symbolised by hand, heart and head, and all are necessary to the complex human social system; it should be the aim of all education to develop the natural bent but not to allow any of these moods to be developed to the exclusion of and disparagement of the others. In the ancient world, the too theoretical Greeks had to give place to the practical Romans, but they, in turn, were too practical and failed to advance human knowledge to any great extent.

A very keen student who came under the writer's notice, and who at one time had a freshness of outlook on practical problems, became obsessed with a love of detail and of dry text-book formula, without having much idea of their applications and of the broad principles underlying them. This case is given as an example of over-specialisation and, needless to say, this student has not got—and probably will not get—very far until he turns his mind more to practical observation and broadens his outlook. There is some merit in deriving a practical formula from observed facts, but little or none in learning, parrot-wise, symbols which to the person concerned, at least, are almost meaningless. The text-book is for reference when needed for a practical purpose, and not for learning the "art of life" from, and if examinations, technical and otherwise, seem to place too much reliance on text-book knowledge, the sooner things are altered the better for everyone.

In continuation class work many students seem to desire a mass of facts without wishing to observe and think about these things for themselves. It must be said, however, that many students are observant of the things they come across in everyday life, and have ideas of their own on the subject, which may or may not be fundamentally wrong, but these students are undoubtedly on the right lines and will be more likely to produce original work and on sound lines when they are guided by proved principles, than those who merely get up a mass of details which, in their minds at least, are quite unrelated. To teach the guiding principles of any subject is probably the best object of every technical course, always bearing the practical applications in mind. Steady working at any set course has its value, as much as mental discipline has in the acquirement of knowledge, but the submission to this discipline should be voluntary, and it is questionable if the compulsory attendance at continuation classes of those over school age, as provided for by the Education Act, will be productive of the good anticipated by those who framed the Act. Still, there are hopes that the real interest which has been aroused in the country in education will result in forcing the flaws to be remedied. Many professors of education, teachers, members of education authorities, and of the general public are quite alive to the real needs in education and are working to remedy the defects. Meantime in continuation class work much time is occupied in teaching subjects that should have been thoroughly acquired at school. In some technical subjects, mathematics forms a powerful lever, but few can "think" on mathematical lines. Scale drawing and hand sketching apply in most occupations in some way, and a much greater use should be made of models or of the appliances themselves in technical teaching. To attempt to outline subjects for ideal courses is meantime of little value, but in evening class work, again, the subjects should be few, simple, and taught in periods of short duration.

The fatigue of a day's work before the class prevents students taking advantage of more than an hour or two of instruction each evening, while two or three evenings per week for the greater part of the year seems to fit in well with the needs of the average student.

For certain highly specialised branches of industry, attendance at day classes at a technical college or university is required with long vacations spent in practical work, but for the great majority this is out of the question. There is no need to attempt to make specialists of everyone, nor is there room for their employment as such, and it is probable that the attempt to force "higher education" on those who have no other desire than to be "hewers of wood and drawers of water" will eventually end in failure. If the desire and interest is there, let there be opportunity for further education, after a certain age, but not otherwise.

In course of time it will probably be necessary to train apprentices in the workshop itself by special instructors who would be selected for particular manual skill, their knowledge of the principles involved and their ability to impart instruction.

Having in view the material presently wasted by apprentices, in the course of their happy-go-lucky training, it would probably pay most employers to pay for those instructors.

An Association of this sort plays its part in the higher education of the individual after apprenticeship days and attainment of his necessary certificates. The opportunity of hearing and discussing papers on all relevant subjects cannot but be of value to all concerned, while the visits arranged to various works tend to a broadening of outlook. Very conscious of the defects of this paper, the writer closes by repeating his main pleas:—

(1). That this Association should consider elementary as well as technical education.

(2). That the human mind must be studied to a greater extent than hitherto, and in a more scientific way, with a development of the practical applications of the science.

(3). That school education should be simpler, more thorough and more individual in application.

(4). That each scholar should be encouraged to appeal more directly to Nature, to think for himself and to develop his own particular qualities.

(5). That a record should be kept of the scholar's physical and mental qualities, apart from the mere results of examinations of the present kind.

(6). That each industry should consider what qualities are desirable in its would-be recruits and that its conclusions should be made available.

(7). That there should be a better means of choosing an occupation than the present haphazard one.

(8). That there should be a closer co-operation between employers and school authorities.

Such a programme is admittedly a vast one, but need it appal us on that account? Surely we can all add something to the structure of human progress, even though it may be only a brick, or even a grain of sand for the mortar.

(To be continued.)

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PAGES FROM OUR DESIGNER'S NOTEBOOK

WESTON ELECTRICAL INSTRUMENT CO LTD

THE WESTON INSTRUMENT AND "ROBUSTNESS"

Robustness in an electrical instrument may be attained in one of two ways.

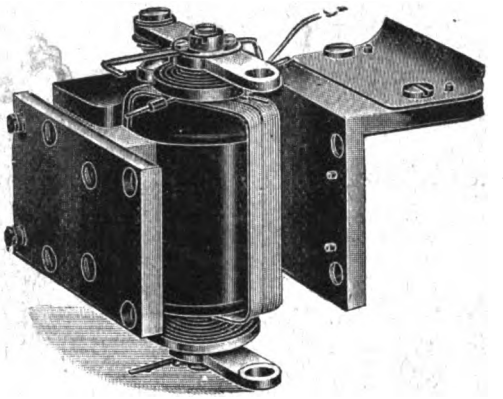
Usually, it is secured by increasing the mass of metal in the moving parts, which course means additional weight and inertia, and therefore wear of the pivots and jewels, and liability to damage under sudden excessive loads. Robustness of this nature is a delusion and a snare, and often an excuse for bad workmanship.

It is readily recognised in the case of an engine that additional weight means a higher moment of inertia of the moving parts, but this fact, in conjunction with all its attendant evils, is often overlooked where instruments are concerned, although it is of vital importance.

The alternative is to reduce weight to the lowest possible proportions and to provide absolutely accurate balancing, together with a damper (for moving iron or dynamometer type instruments) which allows of instantaneous reading, but is at the same time capable of absorbing the severest shock.

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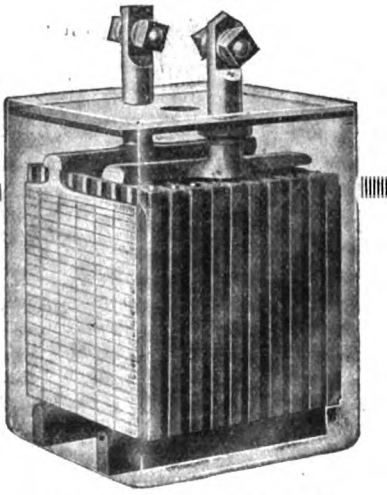
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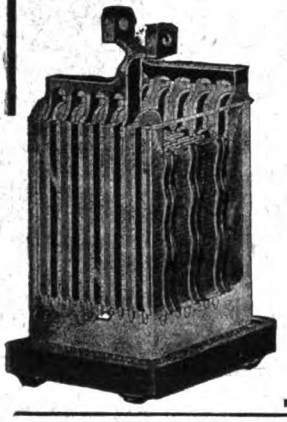
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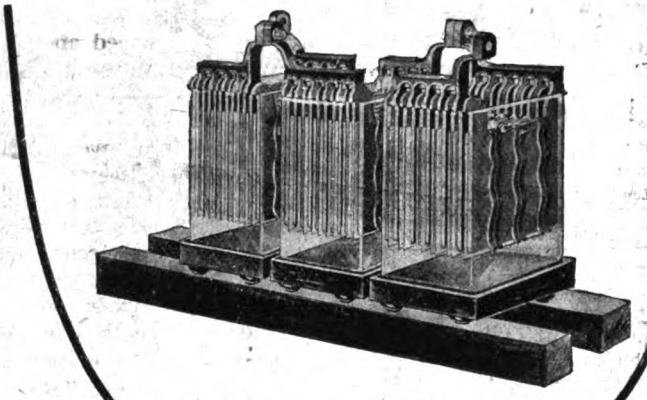
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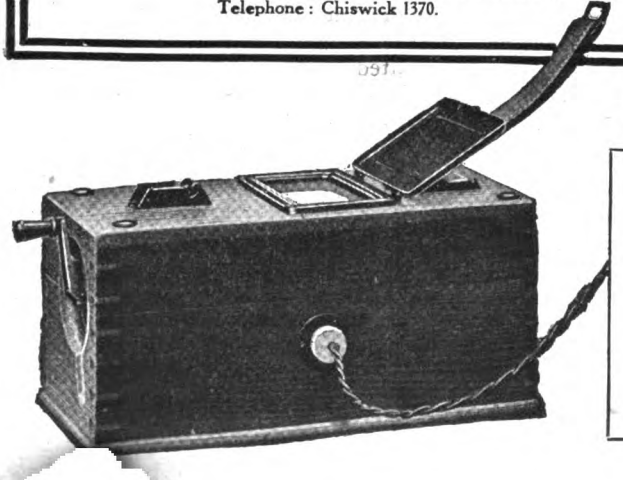


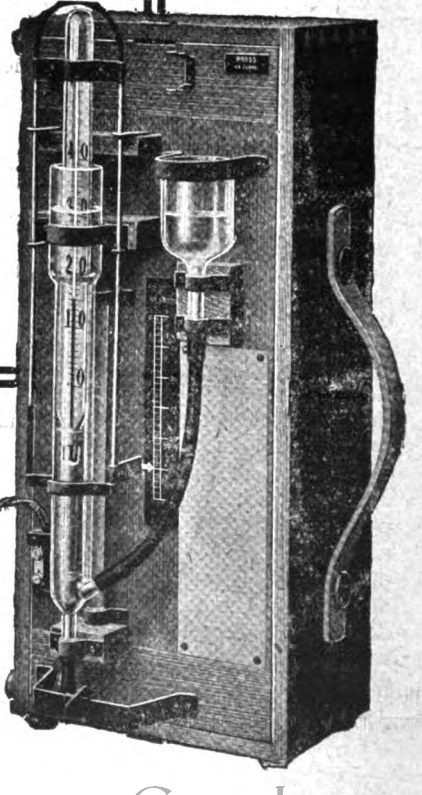
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application.

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Current Topics.

Expert Maintenance.

So complex are our various mechanisms and electrical devices becoming, however simple they may appear to their designers and sponsors, that the need for specialisation was never more apparent than to-day. The Diesel engine is a case in point; admittedly the most economical prime mover of its kind there is, yet an element of doubt in the minds of many power engineers whether the installation of a Diesel plant is the best solution of some of the power producing schemes with which they have to deal. There is entire agreement in engineering circles with regard to fuel economy where this engine is installed, so that the decision rests on first cost and maintenance, the latter being pre-eminent. There is much discussion at the present time regarding the mechanical and operating features of the Diesel engine and exact data regarding the behaviour of existing plants are not available in sufficient quantity to determine the exact status of this class of prime mover.

Operating and maintenance costs of the Diesel engine are vitally dependent upon the man in charge, and in many instances high repair and maintenance costs have been due to incompetence or inexperience on the part of this individual, so much so that one frequently sees advertisements for charge engineers used to Diesel plants. What is particularly applicable to so efficient a machine as the Diesel is equally true with regard to other complex mechanisms and electrical plants. The best of these will not give satisfactory service if they do not receive that small share of expert attention which is necessary to maintain them in fair working order, and it is here that intelligent experience counts. Take motor driving as a concrete example; the man who is in the motor trade and driving practically every day all makes of car probably has good, all-round driving experience, but he will not be able to get the best results out of a given make of car. It is only the man who has driven a particular make consistently, and is thoroughly conversant with all its little faults and adjustments, who can be relied upon to get the very utmost in speed and mileage out of that make, hence the specification in chaffeur advertisements for a man used to ——— cars.

It is the same in every calling; you would not put a colliery winding engineman on to drive an express passenger locomotive, any more than you would select a tram-driver as the best pilot for an electrical launch. Yet both men are accustomed to steam engines and electric motors respectively. The days of the electrical engineer or electrician with all-round experience are numbered, and it is the specialists who are going to rule the roost and command good salaries in the future. My advice to all embryo engineers to-day, whether electrical or otherwise, is to get as much general all-round practical experience as possible during studentship, then select your particular branch and specialise for all you are worth. Make a special study of one or other of the many diverse applications of electricity, and then pick out the most promising plant or apparatus used in that particular field, and find out all there is to know about that particular section. When you have done this you can afford to pose as an expert at your trade or profession, and you will be in a position to save your employer many pounds by way of maintenance and running costs.

Railway Electrification.

When celebrated railway enginers forgather and talk of the future, the rank and file get a glimpse of future possibilities, and such was the case on the occasion of a recent conference at the Institution of Civil Engineers regarding the comparison of steam and electric locomotives. Sir Vincent Raven, who introduced the subject, was particularly optimistic as to the future, and instanced experiences of electric traction between Shildon and Newport. Electrification enabled fuel consumption to be reduced to one-half or one-third that with steam locomotives, the fuel employed being of a quality unsuitable for steam locomotives. Furthermore, prior to 1915, the cost of repairs with electric locomotives was one-third what it was with steam.

Sir John Aspinall, another competent authority, also supported the case for electrification, but stated that much remained to be learnt regarding main-line conversion. He anticipated considerable benefits from the experience to be gained after the electrification of the North Eastern main line between Newcastle and Darlington. His conception of the work of an electric locomotive was that it should start right away, say from the North of Scotland to the South of England without any change save in personnel. Every possible minute of work ought to be got out of it; and immediately following its arrival at its destination, the question ought to be how soon could it start on the return journey. The man in the cab of an electric locomotive would be a gentleman with no duty save that of watching over the lubrication and keeping the machine clean.

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Another Post Office Monopoly.

Since the Post Office has been undergoing such a storm of criticism of late, especially in connection with its alleged mishandling of the telephone system, I do not wish to be accused of "rubbing it in," but it is rather a coincidence that whilst my last week's notes were being penned the engineer and surveyor to the Wellingborough Urban District Council was busy voicing his opinion of a Government Department which had the temerity to lay expensive and easily damaged cables in readily fractured earthenware conduits, only fourteen inches below the surface of the pavements in Wellingborough and then mulct the Council in heavy damages when those same earthenware ducts were accidently broken and the cable damaged.

It certainly does seem like asking for trouble so light to bury, and so inadequately protect, those important links in our inland telephonic communication, the Wellingborough Post Office Telephone cables. Every telephone engineer realises the desirability of placing telephone circuits below ground, and comprehends, moreover, the reason for enclosing them in earthenware or other non-metallic conduits. The principal negligence in this case appears to have been the comparatively shallow trenching, and the absence of some mechanical protective medium above the fragile earthenware of the ducts. In these days of multiplicity of buried mains of all kinds, water, gas, electric light and power, hydraulic, telephones and telegraphs, there is a maze of subterranean construction beneath the streets of most busy towns, and it is really surprising that more accidental damage does not accrue when the workmen attached to the various interested departments get to work with their picks and shovels.

The ideal solution is, of course, properly constructed sub-ways for all such services, running under and parallel with the principal thoroughfares. They involve the minimum of disturbance of the roadway and pavement, permit of ready inspection, testing and alteration of existing services. On the other hand, they are very costly, and it is questionable whether their general development will extend in provincial cities and towns for this reason. A less expensive compromise should be possible on the "cut and cover" principle, involving a general trenching of the principal side-walks for the reception of all the usual mains, the excavations being subsequently covered in by suitably supported roof members, with provision at intervals for the necessary manholes or inspection covers. The cost of such a trenching system should not work out appreciably higher than that of individual mains laying, if only the various interested authorities could be induced to co-operate amicably and to the advantage of the man in the street—who, incidentally, pays.

German Generating Plant Coming Again.

I have dealt on many occasions with the absurdly high prices of British manufactures, brought about by inflated wages and ca' canny. These conditions have effectually damped down our export trade and now threaten the home trade, as evidenced by the receipt of a tender for a 10,000 kw. turbo-set of German manufacture at half the lowest British quotation, between £90,000 and £100,000. There is also a Swiss tender at £80,000. It is not only cheap fuel and increased output per man employed that enables Germany to underquote us, but the exchange rates are an important factor. Anyhow, we have got to reckon with these factors, and must reduce our prices if we are not all to be unemployed. At the time of writing the various tenders have not been finally considered by the Sheffield City Council, but the results of its deliberations will be known shortly.

ELEKTRON.

SETTLEMENT.

The settlement of the coal dispute is not going to give us cheaper coal—at any rate, not immediately. The price of industrial coal is to remain the same, with, in some cases, an advance in price for locomotive coal and a general advance for household and gas coal of 3s. per ton. All industrial upheavals have to be paid for, and the sooner this is thoroughly appreciated the better.

The general body of workers certainly now seem to understand this fact, and to the long list of Unions which have accepted reductions in wages without much friction has now to be added the Engineering Unions. These have now, on a ballot of the men on the amended offer of the employers, agreed to accept a reduction of 3s. per week on time rates on July 15 and a similar reduction on August 15, while the question of the withdrawal in stages of the 12½ per cent. bonus for time workers and 7½ per cent. for piece workers, granted by the Ministry of Munitions during the war, is held over till September. The sooner the men realise that these *must* come off the better. In the meantime we are thankful that wages are now moving in the right direction, and, coupled with increased output, we may begin to regain some of our lost trade—a necessary prelude to a further fall in the cost of living.

Answers to Correspondents.

MR. F. MCKAY (Glasgow).—The amount of power that a circuit has to carry is not taken into consideration when the insulation resistance of the circuit is tested. As, from the details you send, you appear to be under the impression that it does, we cannot do better than quote you Rule No. 121 of the Institution of Electrical Engineers. It is as follows:—"The insulation resistance to earth of the whole or any part of the wiring must, when tested previous to the erection of fittings and electroliers, be measured with a pressure of not less than twice the intended working pressure, and must not be less in megohms than 30 divided by the number of points under test. For this purpose the points are to be counted as the number of pairs of terminal wires from which it is proposed to take the current, either directly, or by flexibles, to lamps or other appliances."

Regarding the operation of the megger for testing insulation resistance, this is dealt with in almost every text-book. See the "Practical Electrician's Pocket Book."

S. H. ADAMS (Sutton, Surrey).—Herewith replies to some of your questions. Questions Nos. 3 and 5 will be published for competitive replies in our Questions and Answers Competition, since they are questions which are of interest to other readers. (1) The Scott system of transformation may be said to be a method by which the supply is changed from three-phase to two-phase or *vice versa*. In this system two transformers have their primaries T connected to a three-phase supply. Their secondaries are independently connected so that a true two-phase supply is available. The neutral point on the three-phase side may be said to be the junction of the T. (2) You cannot do better than to write to the British Insulated Wire Co., Prescot, Lancashire, for their handbook. This will give you the information you require concerning paper insulated cables. (4) If you consider the reply to (1) you will see that it is possible.

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THE LONDON ELECTRICITY PROBLEM.

(*Continued from page 373.*)

Fairly rapid progress has been made with the inquiry by the Electricity Commissioners since the scheme for the nine companies was laid before the Commissioners. The case for this scheme has now been completed, the next scheme for consideration being that promoted by the Poplar Borough Council. There still remain, however, two railway schemes, whilst all the opponents have to be heard, together with counsel for the various schemes.

So far as the scheme of the nine companies is concerned, this adopts the technical scheme already referred to, which has been prepared by Sir Alexander Kennedy, Mr. G. W. Partridge, Mr. Rider and Mr. Wordingham—e.g., the existing stations will be extended up to their limit, practically, and the building of any of the four proposed capital stations will be postponed at least until 1925 and possibly even until 1931. That being so, attention was devoted to the administrative side of the scheme—as referred to in our last issue. Arising out of this question is the purchase or acquisition by other means of the existing generating stations and transmission mains. The L.C.C. scheme proposed that there should be compulsory acquisition by the joint authority, which should have an engineer with absolute powers until such purchase actually took place, to deal with the load over the whole area, ordering this or that station to close for certain periods of the day, or even altogether. Neither the scheme of the Conference of Local Authorities nor the nine companies assumes any compulsory powers or dictatorial authority of that nature. In both these latter cases acquisition is to be by agreement, and great faith is placed in the common-sense of the central station engineers to carry the scheme through without friction.

Then arises the question of purchase of the generating stations and transmission mains, on this voluntary basis. So far as the companies are concerned, they propose that the joint authority should acquire their stations and mains on the terms of payment of the cost, less depreciation on the Income Tax basis, either in a lump sum or by instalments. On the other hand, the local authorities, under their scheme suggest that the terms of repayment should be as above or by taking over the whole of the outstanding debts of the undertaking. In addition, the companies stipulate that instead of being purchased outright in 1931 by the L.C.C., as will be the case as matters now stand, they should be given an additional lease of life, and for fifty years after 1931 act as distributors. The L.C.C. is not averse to that.

So much for the broad outlines of the three schemes of the L.C.C., the Conference of Local Authorities and the nine companies.

The next scheme to be considered was that promoted by the Poplar Borough Council, and known as the East London Scheme. This proceeds on an entirely new principle compared with the others. The promoters lay it down that industrial London, which constitutes the whole of the East of London and certain districts south of the Thames, is a sufficiently large and important one to warrant being constituted a separate authority from the remainder of the area, with complete financial autonomy, although electrical interconnection might take place on a mutual basis. For this reason a certain area has been defined, which is termed the industrial area, in which it is claimed that supply can be given now more cheaply than in the rest of the larger area defined by the Commissioners, and that in the interests of industry that low price should not be jeopardised by being compelled to link the area up with the other parts of London financially. At first it was suggested that a separate joint authority should be formed for the area quite distinct from any joint authority which might be formed for the rest of London, but as the case progressed, it was agreed to limit the demand for separation to the appointment of a district committee, within the larger joint electricity authority, but with independent financial powers of its own. It is frankly confessed that Poplar has not the support of any authorised distributor—company or local authority—in the area which has been selected, but the engineers to the scheme, Mr. J. H. Bowden, chief engineer at Poplar, and Mr. E. M. Lacey, seem fairly confident that they will be able to bring about co-operation of all parties by offering sufficiently tempting terms for supply. One point in the scheme which has received much criticism is the method of going to work which is proposed in regard to working out the scheme. There is to be a committee of engineers of the various stations who will make suggestions as to new plant, closing down, and so on, to the district committee, which, in turn, will report to the joint authority for the whole of London. Failing agreement between these three bodies, there is to be an appeal to the Electricity Commissioners. Against the obvious disadvantage of such a process, it is pointed out that the undertakings in the East of London have been linked up, on a voluntary basis, for ten years, and have afforded each other such useful assistance that anything between £1,500 and £2,000 per annum has been saved in the coal bill on each of the four undertakings concerned.

(To be continued.)

THE GLO-CLAD ELECTRIC WIRING SYSTEM.

A simple and efficient wiring system, which is watertight, gastight, acid-proof, and electrically continuous, has been introduced by W. T. Glover and Co., Ltd., (Trafford Park, Manchester). It is called the Glo-clad system, and in its design primary attention has been paid to technical merit. The cable, which is rubber insulated, is stocked only in 3/.036 in. single and 3/.036 in. twin (only the latter should be used on A.C.), and is provided with a continuous watertight lead alloy sheath, which is itself screwed at all joints and terminals. It is sufficiently ductile to permit of the cable being bent during erection and rigid enough to prevent unsightly sagging.

There is a special range of Glo-clad fittings for use with the cable, but the following special tool only is required for erection:—a die, of the "Card" type, for making the thread in the metal sheath, though the Glo-clad combined stripper or a modification for use with C.T.S. and other rubber-insulated non-metal sheathed cables is a desirable

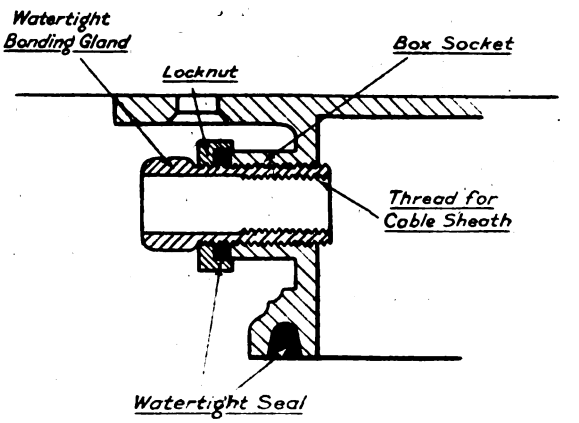


FIG. 1.—CORRECT POSITION OF GLO-CLAD BOX GLAND BEFORE THE CABLE IS THREADED THROUGH IT.

alternative to the pocket-knife method of trimming cables. At all junctions and terminals the Glo-clad cable is bonded and sealed by means of an internally screwed brass gland (Figs. 1 and 2) fixed in a watertight iron box. Intimate bonding is obtained by screwed contacts, and watertightness is secured first by screwing the gland into the box, next by screwing the gland back along the cable sheath, and finally by means of a gasketted locknut, which completes the water seal, no flame, hot metal or soldering

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iron being needed. When installed in an acid-laden atmosphere these glands are enclosed and painted, and in addition, the cable is provided with an acid-resisting braid.

Rubber insulated flexibles and cables of the "Cabtyre" type may also be used in conjunction with Glo-clad fittings, the boxes being then provided with suitable stuffing-box

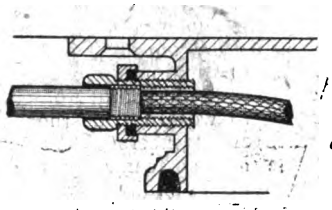


FIG. 2.—CORRECT POSITION OF SCREWED CABLE WITHIN THE GLAND.

nipples instead of the standard bonding gland. For industrial installations a perforated steel tray for supporting the cable under girders may be used. It it a labour-saving device and is of neat appearance. Clip and saddles are provided.

Switches are of the ordinary standard pattern, totally enclosed in watertight iron boxes and operated externally by a radial fork on the end of a screwed arm.

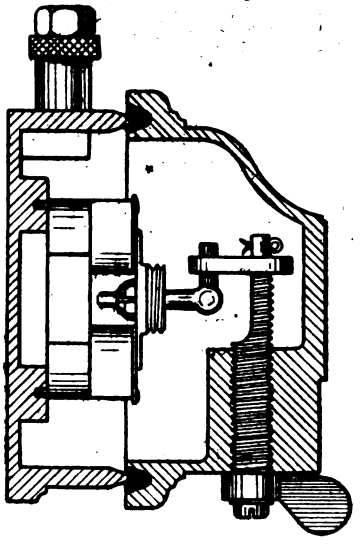


FIG. 3.—SECTION OF GLO-CLAD WATERTIGHT SWITCH.

Suitable fittings are available to meet various requirements. The standard designs adopted have been chosen with the object of satisfying a variety of working conditions with a minimum stock of accessories.

Illustrated particulars of the system, including simple "instructions to wiremen," are contained in List No. 14, which may be obtained from W. T. Glover and Co., Ltd.

LEEDS AND OIL FUEL.

Exhaustive experiments and tests with regard to the relative merits of coal and oil fuel—economic and otherwise—are to be conducted by the Leeds Corporation Electrical Department now that the coal dispute is settled. During the existence of the trouble the works have been kept going by means of the installation of an oil fuel burning plant, but the authorities have had some anxious times in consequence of the uncertainty of the arrival of further supplies of oil. On one of two occasions, it is on record that the oil supply was very near exhaustion when fresh consignments arrived opportunely or in the nick of time.

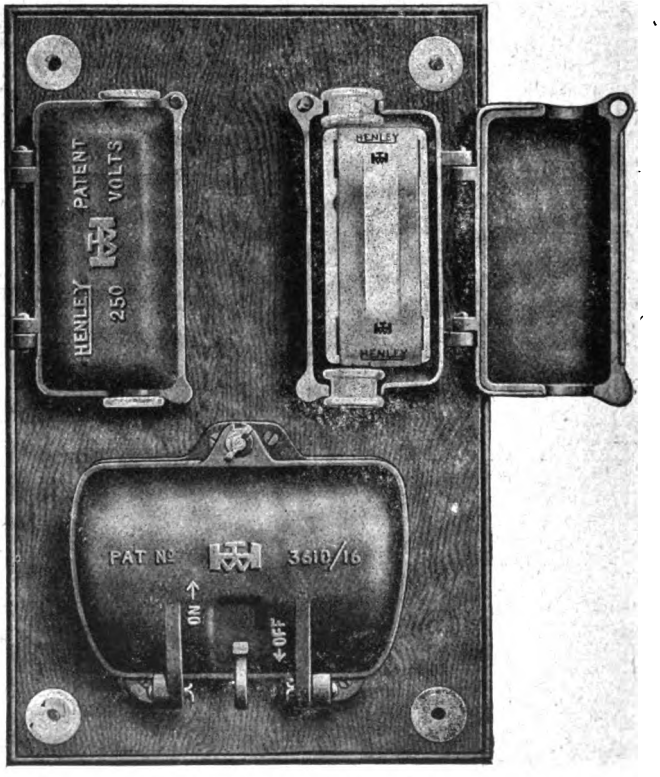
NEW WIRELESS TEACHING FACILITIES AT THE POLYTECHNIC.

The Polytechnic (309, Regent Street, W.1) has been for long particularly well equipped and staffed for the teaching of telegraphy, telephony and wireless, but the wireless equipment has just been made more valuable by the addition of a large aerial on the roof whereby students can listen-in, pick up time signals from the Eiffel Tower and hear conversations between various stations, or receive messages. On Thursday, July 7, a demonstration was given in conjunction with the Marconi Co., thirty receiving sets being connected in series parallel. Messages were sent out by the Marconi Co. from Chelmsford through their standard half-kilowatt set and were heard plainly at the Polytechnic, as also were time signals, bits of messages, etc., while, owing to experiments from a neighbouring station using the same wave length the listeners got at one time a good experience of jamming.

Some introductory remarks were made by Mr. J. E. K. Studd, Director of Electrical Engineering, while Mr. J. W. Turner, head of the Telegraph and Telephone Section of the Electrical Engineering Department, gave a popular lecture on wireless, in which he built up the wireless circuits by easily understandable steps from the simple electric bell circuit.

HENLEY IRONCLAD SERVICE CUT-OUTS.

W. T. Henley's Telegraph Works Co., Ltd., have recently introduced some new features in their extensive range of Ironclad Service Cutouts. Included is a 500-volt double-pole switch, for 10 to 100 amps., designed to comply with the latest H.O. requirements. There is also a range of double-pole Bridge type service cut-outs for two, three and



four-way, S.P. and neutral, for heating and lighting circuits. The illustration shows one of the switches just referred to, mounted, together with two S.P. ironclad cut-outs, on a new design of 5-ply backboard. The backboard is made from hardwood, given a teak finish, polished back

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The "Cosmos" Electric Iron.

Exhaustive experiments have been carried out by our Research Department at Trafford Park Works, Manchester, with the object of arriving at the actual requirements of an average household ironing.

The "Cosmos" Domestic Iron embodies all the conclusions arrived at by these scientific investigations, and the result is a thoroughly reliable and efficient household appliance.

The ideal ironing temperature, neither too high nor too low, is maintained uniformly even to the point on the under surface of the Sole Plate, and the iron is ready for use in three minutes after switching on. The general construction is robust, while precautions have been taken to avoid damage to light fabrics.

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Domestic Iron.

The "Cosmos" Iron is packed in a neat cardboard box plainly marked with loading particulars, thus facilitating the keeping of stocks and at the same time providing an effective window display.

THE HANDLE DOES NOT GET HOT.

THE END STAND AVOIDS CONTINUAL LIFTING.



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Have you had a copy of List Y.150/12?

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THE SIMPLEX SAFETY ALL-STEEL SYSTEM OF CONDUIT WIRING for the efficient encasement of electric wiring cables consists of a combination of smooth bore steel tubes or conduits used in conjunction with malleable cast-iron fittings and accessories, so as to form a complete covering, specially designed to meet the requirements of high-class installation work, and effect the saving of time and labour in erection, with the further object of bringing about a general reduction in the cost of efficient conduit wiring.

The Simplex Conduit System has been developed through a period of almost a quarter of a century and is the outcome of patient labour on the part of our designing and manufacturing engineers, whose energies have been continually directed towards the betterment of the Simplex Conduit Wiring System; and it is not surprising to note that to-day many thousands of installations carried out on the Simplex System are, as a natural consequence, giving continuous satisfaction throughout all parts of the world.

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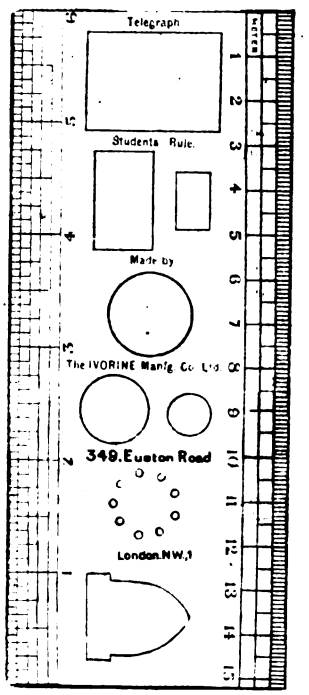
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Particulars of the full range of Henley Ironclad Service Cut-outs are contained in the new 40-page price list, No. W.L.I., which is now available for the use of the trade.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 121.

Can any reader give me full details of the use and operation of the Tesla coil?—J.E.H.

QUESTION NO. 122.

Please can any reader give me full details of checking the ratios of various transformer connections, preferably "Scott," "Zig-zag," etc.?—J.E.H.

(Replies to Questions Nos. 121 and 122 must be received not later than July 30, 1921.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.

ELEMENTARY TELEGRAPHY. By H. W. Pendry. (Pitman. 7s. 6d. net.)—The issue of a second revised edition of this text book, already well known to many telegraphist readers, is in itself a sign of popularity, and the one under review is a worthy successor of the original book by this author. The telegraph art is rapidly becoming so complex by the introduction of mechanical means for the transmission and reception of signals, as well as their reproduction in printed characters, either on tape or in page form, that the student needs some elementary treatise to prepare his mind for the wider fields opened up by Wheatstone, Baudot, Creed, and other pioneers of the modern school of thought. The treatment of the subject, under six main heads—Fundamental principles, batteries, instruments, lines, systems and miscellaneous—is good, the addition of an appendix of C and G examination questions enhancing the value of the book to the student. The information given is sound, practical and clear; if one may be allowed to criticise, the illustrations as a whole are disappointing and seriously detract from the finish of the book. The line drawings are poor and lack uniformity, some of the diagrams being on too small a scale as regards lettering and references. The half-tones also are not of the best, but the fault may lie with the printers. The price is somewhat high for the size and scope of such a work and by comparison with other similar text books.

WIRELESS DESIGN AND PRACTICE. By M. B. Sleeper. 246 pp., 112 figs. (Frowde, Hodder and Stoughton. 7s. 6d. net.)—A few years ago it was difficult to find any books upon the practice of wireless telegraphy, but now the difficulty is to pick the best from the great number of works on the market. We know of no book likely to be more useful than the one now under review to the up-to-date amateur in wireless telegraphy and telephony. The book is most readable and is excellently produced, there being a number of splendid photographs of modern wireless apparatus as used in practice and a great number of wiring diagrams showing all the known circuits which are of practical importance. In the first part of the book the problems of design of transmitters and receivers are dealt with in language which should be easily understood by the average experimenter. The few formulæ required are given in their simplest terms and calculation is eliminated as far as possible by the inclusion of a number of tables which will be found most helpful. The reader should have no difficulty in appreciating the relative merits of the various types of apparatus and in constructing satisfactory apparatus to give the desired results. Chapters are devoted to the general characteristics of oscillating circuits; to types and characteristics of aerials, including aeroplane aerials; to the design of inductances and condensers; and to valve detecting circuits, oscillating valve circuits, and undamped wave receivers. Both damped wave transmitters and vacuum tube transmitters are considered fully. The second half of the book consists of a unique collection of wiring diagrams of practical circuits. Brief notes are given concerning the principal features and purpose of each circuit, and space is left for the reader to add his own notes concerning results obtained and so forth. We have no hesitation in recommending this as a sound and thoroughly useful book.

KINEMA OPERATOR'S HANDBOOK. By W. S. Ibbetson. 151 pp., 37 figs. (Spon. 4s. 6d. net.)—So excellent are "the pictures" in the modern kinematograph theatre that the average member of the audience gives never a thought to the operator, on whose knowledge and skill the quality of projection depends so greatly. The present-day kinema operator must be something of a mechanic and optician, and largely an electrician. High demands are made on his manipulative skill and judgment, but in the past there have been too few books giving him practical assistance of the sort he requires. We have examined the present book critically from the practical standpoint and we believe that it will quickly gain wide popularity amongst the men for whom it is intended. Broadly speaking, it should appeal to all those who use or who wish to become acquainted with the method of operating the modern kinema projector and with the principles underlying its working and that of the electrical apparatus connected with it. The requisite theoretical knowledge is presented in such manner that it can be learned easily and thoroughly and applied intelligently to practical work. This being accomplished, clear instructions are given for actually operating the projector and its electrical auxiliaries. No fully qualified operator can ever be made by bookwork alone, but it is safe to say that no operator is fully qualified who is not familiar with all the information given in this book. To the beginner the volume will be invaluable and there are few practical operators who would not read it with profit and enjoyment.

The optical system is dealt with in detail, the components of the projector mechanism are separately illustrated and described, about one-third of the book is devoted to the electrical apparatus and its maintenance, whilst the chapter on practical operating covers all likely contingencies. The final chapter deals briefly with the special points of a few standard and new projectors.



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Various Items.

Burnley.—The electrical engineer has reported that through industrial disputes the additional generating plant will not be available to meet next winter's load.

I.E.E. Benevolent Fund.—The offer of Mr. H. M. Hughman, of Bombay, to give a donation of £250 to the I.E.E. Benevolent Fund on condition that 19 similar amounts were contributed by June 30, has been extended by him to Dec. 31, 1921.

Minimum Payments.—A leaflet, (No. 175/1921), issued by the Electrical Development Association, explains why suppliers of electrical energy are authorised to ask consumers for a minimum payment per quarter. It is written in a reasoned style, which cannot but be convincing.

Tenders Accepted by the L.C.C.—Among tenders for equipment in the new County Hall, the following have been accepted: Two passenger lifts, Waygood-Otis, Ltd.; one goods lift, Express Lift Co., Ltd.; two book lifts, Express Lift Co., Ltd.; main lighting switchboard, Dorman & Smith, Ltd.

Newcastle (County Down).—At a meeting of the private consumers, the proposal of the Electric Supply Company to charge meter rent at the rate of 2s. per quarter, and a minimum charge of £2 per annum for current, was considered. It was unanimously agreed to refuse to accede to the proposal and to support the Urban Council in any action they might take.

Personal.—Mr. George Hally, of Birmingham, has been appointed Chief Works Manager of the engineering side of the Edison Swan Electric Co., Ltd., Ponders End, Middlesex. Mr. Hally has had a wide experience with some of the leading firms of engineers in this country and abroad, and served his apprenticeship with Messrs. Alley and McLellan, Ltd., Glasgow, of which city he is a native.

Claims against Germany.—The B.O.T. announce that by an agreement with German Clearing Office, now awaiting the approval of the Reichstag, the time for lodging claims with the British and German Clearing Offices by their respective nationals under Article 296, Section III., Part X. of the Treaty of Versailles has been extended to Sept. 30, 1921. No further claims under the above Article will be accepted after that date by the Clearing Offices concerned.

New Pirelli Co.—A new company under the name "Societa Egiziana Prodotti Pirelli" has been constituted in Egypt to manufacture and sell india-rubber goods, electric cables and accessories, and cotton goods used in their production. The company is Italian, with headquarters at Milan, and the capital is £E.60,000 in £E.20 shares. Directors: Dr. Piero Pirelli and Dr. Alberto Pirelli, represented by Commander Ugo Cavallero, of Milan, Mr. Camillo Viterbo, Mr. Rurio Lucuc and Mr. Roberto Auritano, of Alexandria.

Swansea's Electricity Profits.—The chairman of the Electricity Committee (Colonel Alex. Sinclair) announces that when the balance sheet is published it will be shown that a profit of £3,785 has been made after clearing capital charges, etc. As they were the only undertaking that had advanced their charges by as little as 50 per cent., that coal had been scarce, and that they had temporarily lost some of their customers, he thought the result splendid, but in view of the present conditions they could not hope to carry on quite so cheerfully as in the past.

Sloan Electrical Co., Ltd.—The printer followed the photo-engraver, who thought that he knew better than the people who gave him the order, how Philips' should be spelt—with the result that in our article describing the new showrooms of the Sloan Co. (ELECTRICITY, July 1, pp. 365/6), the ½ c.p. night lamp was referred to as being manufactured by Phillips' Glow-lamp Works, Ltd. In order to avoid any possibility of a misunderstanding it should be noted that the manufacturers are the world-known firm of Philips' Glowlamp Works, Ltd. [One "l" please, Mr. Printer!]

Crompton & Co., Ltd.—The net profit for the year to March 31, 1921, after providing for depreciation, E.P.D., Corporation profits tax, income tax, etc., is £66,292; to which is added the carry forward from last year of £18,177. After placing to general reserve £19,500, 10 per cent. is to be paid on the Preference shares and 10 per cent. is recommended to be paid on the Ordinary, leaving a balance to be carried forward of £18,370. The stock-in-trade and work in progress appears in the report as £365,002 (at cost or under—the directors stating that in order to cover the abnormal fall in prices and material an exceptionally large sum has been written off stocks). There are 6,010 employees' preference shares which are entitled to a bonus of 3 per cent. per annum in addition to the dividend.

Wages Reduction.—On the first pay-day after the 9th inst., 10 per cent. reduction on the wage rates current in April was by agreement between the N.F.E.A. and E.T.U. substituted for the 5 per cent. reduction in force up to the 9th inst. This reduction applies to all grades of the national wages agreement for the Elec. Contracting Industry, to journeymen mates, assistants and foremen. No new hourly rate is to be arrived at, but 10 per cent. deducted from the total wages calculated on the April hourly rate (exclusive of allowances). It is to be hoped that next time the E.T.U. will agree to new hourly rates.

"Power House Design."—A new edition of this well-known text-book by Sir John Snell has just been published. It has been carefully revised and brought up to date, and represents the latest progress in connection with central station work in this country and abroad. There is no doubt therefore that it will meet with a ready sale among central station engineers and all who are interested in this particular subject, and we should advise any reader who wishes to study it to lose no time in purchasing a copy. It is a book of 535 pages, profusely illustrated and the price is 42s. 9d. net, post free, from ELECTRICITY" office.

Trade Notes.

British Insulated and Helsby Cables, Ltd. (Prescot, Lancs), have issued a new comprehensive list of Prescot paper insulated and lead covered cables for lighting and power, with reference to Prescot telephone cables. Sectional illustrations of the various cables together with particulars, are given.

The prices of various "Magnet" electric heating and cooking appliances are now reduced by 15 per cent. The appliances affected are enumerated in a leaflet just issued by the **General Electric Co., Ltd.** (Magnet House, Kingsway, W.C.2), which company has also issued a leaflet, No. OS 2538, giving particulars and prices of cases for the safe custody of spare Osram automobile lamps.

Bruce Peebles & Co., Ltd., have recently appointed Charlesworth Peebles & Co., of 134, St. Vincent Street, Glasgow, as their agents for the whole of Scotland, with the exception of the area in the East of Scotland, which for many years has been efficiently covered and will still be covered by Mitchell Graham and Son, Ltd., 56, Buccleuch Street, Edinburgh. This new development does not in any way affect the position of Mr. J. A. Hood, who still remains Bruce Peebles' Scottish representative.

The Benjamin Press and Postal Advertising campaign to bring home, particularly to manufacturers and industrialists, the advantages of adequate illumination provided on scientific lines is still in full swing. The latest announcements are of more than ordinary interest. One gives a list of authorised factors who are identifying themselves with Benjamin products and Benjamin progress, a second deals with Benjamin industrial signals, while two others are on the subject of the Benjamin system of industrial lighting. Of the latter announcements the one headed "Could you see in a Fog" is particularly appealing. The address of **The Benjamin Electric, Ltd.,** is Brantwood Works, Tariff Road, Tottenham, N.17.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
JULY 22, 1921

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THE RAPID AND ECONOMICAL MAINTENANCE OF ELECTRICAL MACHINERY.

By C. W. BRETT.*

The arch-enemies of commercial progress are industrial unrest and mechanical breakdown. For the first there is, apparently, no positive cure; for the second, scientific discovery has found an entirely reliable remedy, so that, to-day, every industrial metal can be reconstructed or re-created in such a manner as to restore its pristine efficiency, and enable it to withstand the incessant ravages of friction and the stresses and strains to which, from time to time, all productive machinery must be subject.

The immense utility of welding in the economic maintenance of all descriptions of machinery may be gauged from the fact that there is scarcely a component, fabricated of any industrial metal, which has not been repaired in a manner which leaves its original qualities unimpaired—that is to say, in a manner which permits of exactly 100 per cent. efficiency.

Given expert direction and skilled operators failure in scientific welding—or autogenous fusion, as it is sometimes called—is practically unknown. It has been proved beyond all debate that in competent hands the rehabilitation or reclamation of all industrial metals means, at least, a 50 per cent. reduction in upkeep charges, and an immense saving of time—which is an equally important desideratum.

CONDITIONS OF SUCCESS.

Of course, in this, as in all other highly technical processes, good results depend wholly and solely upon the knowledge, skill and experience of the operator, and the soundness of the direction under which he works. This point cannot be over-emphasised. It is a comparatively simple matter, given the requisite equipment, to unite two pieces of metal by fusion, but mere junction is not welding, as has been conclusively demonstrated by X-rays, radio-metallographic examination, and exhaustive laboratory tests. In every operation, from first to last, the craftsman is confronted by problems—varying with each job—which tax skill, ingenuity and patience to the utmost.

Someone has said that science is never simple, and to this dictum welding is no exception. Only the specialist or metallurgical expert can determine precisely what should be done, and which of the half-dozen processes commonly employed is required to effect a complete rehabilitation. Ignorance in this matter has been responsible for the wholesale destruction of valuable machinery. The workshop of every welding specialist is positively littered with mechanical wreckage—awaiting reconstruction—which is directly due to the mishandling and incompetence of unqualified welders.

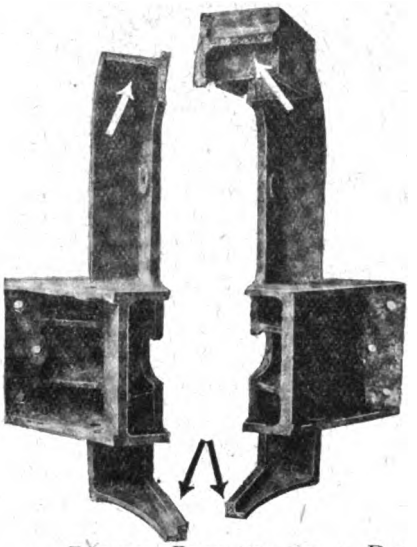


FIG. 1.—BROKEN BEDPLATE OF A DYNAMO.

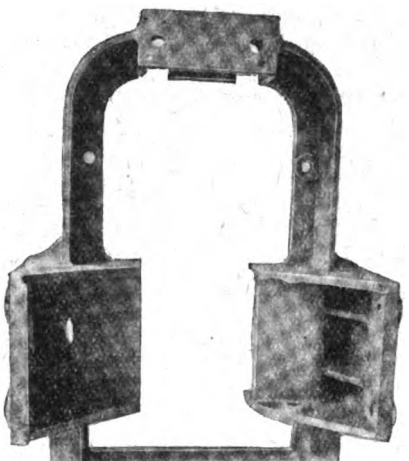


FIG. 2.—THE SAME BEDPLATE AFTER REPAIR BY SCIENTIFIC WELDING. THE BEDPLATE WAS ALSO MACHINED, LINED UP AND FACED, AND THE WELDED PART WAS STRONGER THAN THE ORIGINAL METAL.

THE SCRAP HEAP.

To such a state of perfection has welding practice been brought that to-day a waste metal dump is a reproach and a definite reflection upon organisation.

Many a really serviceable part has been "scrapped"—by those unaware of the possibilities of autogenous fusion—which by the skilful application of welding

* Managing Director, Barimar, Ltd., The World's Scientific Master Welders.

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might have been restored to full commission and years of efficient service. Whether worn or fractured, rusty or bright, old or new, every component is capable of re-creation by high temperature treatment. Short of pulverisation, or damage to such an extent that it becomes unrecognisable, there is not a breakage or injury in cast iron, cast steel, wrought iron, alloy steel, aluminium, bronze or gun-metal that cannot be rapidly, economically and permanently restored to its pristine condition by this means.

THE NEED OF THE HOUR.

In these days of exorbitant prices and extortionate charges, economy is the thing of paramount importance; and the first step in this direction is a careful investigation into the claims of scientific welding. If this is done, it is not too much to say that maintenance charges will decrease by 50 per cent., while 100 per cent. efficiency will be maintained.

To those who have no experience in welding repairs the following incomplete list of machines and components which have been completely reconstructed will indicate the scope and value of this process of restoration. Each of the parts successfully passed rigorous laboratory tests, and, on replacement, has stood up to every demand made upon it.

Boilers (all kinds), furnace fittings, mechanical stokers, armature shafts, dynamos, switch and fuse boxes, transformers, metal meter cases, conductor rails, motor parts, tramway frames, wheels, axles, commutator parts, generators (all types), switchboard fittings, turbines, fans, hydro-electric plant, electric cranes, elevators, pumps, compressors, electric transport units (all kinds), and all descriptions of generating station equipment and apparatus.

These are the things which prove that scientific welding is a factor—and in all probability the greatest factor—in the economic upkeep of all classes of electrical plant and machinery.

It is not long since an eminent engineer said in reference to autogenous fusion: "No machine is 'dead and done for' nowadays until you can mix it with filings and not see it!" This statement—despite its jocularity—is nearer the truth than many machinery owners suppose.

FINALLY.

No machine or component, whatever its condition, should be scrapped until after it has been submitted to, and examined by, an expert metallurgist who specialises in *all* branches of scientific welding. Whether the part weighs four ounces or four tons it can, in 98 per cent. of cases, be restored to full and permanent service.

But only if it be entrusted to a firm whose qualifications are unimpeachable.

G.E.C. REPORT.

The report and statement of accounts of the General Electric Co., Ltd., submitted at the Annual General Meeting held at Magnet House, Kingsway, on the 21st inst., show very satisfactory results of the year's trading to March 31 last. After meeting all charges a dividend at the rate of 10 per cent., free of Income Tax, is declared on the ordinary share capital, leaving £348,094 to be carried forward subject to E.P.D. (if any) and Corpn. Profits Tax. It is interesting to note that the net profits reach the sum of nearly one million pounds, actually being made up of £796,149 net profit for the year, plus £175,668 brought forward from the previous year. The capital of the company is £6,000,000 and the number of employees on March 31 was over 16,000.

The Report states that "owing to the present state of industry, the directors consider the usual allocation to reserve out of profits inadvisable, and recommend that the amount which they would have allocated under normal conditions should remain in the 'carry forward' to next account, which thus stands at the total of £348,000. They feel all the more justified in making this recommendation as the Reserve Account has benefited during the year by the sum of £257,016, through the transfer of net premiums received on the share issue of March, 1920, thus making the total of this account over £700,000."

"The assets of the Co. as shown in the Balance Sheet amount to over £11,000,000, an increase of approximately £4,000,000 upon last year's figures.

"The considerable increase in the Fixed Assets is mainly accounted for by the absorption of the Peel Conner Co., with its works at Manchester and Coventry, the further large extensions to the engineering works at Witton and the Osram Works at Hammersmith, and the completion of the building in Kingsway. These additions were all approaching completion on March 31, and have been carried out by considerable financial assistance from the Co.'s bankers, which liability has been met since the close of the financial year by a debenture issue."

Mr. Maurice Solomon has resigned from the Board of the G.E.C. on his appointment as Managing Director of the Pirelli-General Cable Works Ltd.—one of the Co.'s allied organisations. Mr. M. S. Conner has joined the G.E.C. Board.

THE "ELECTROLUX" VACUUM CLEANER IN USE.

The "Electrolux" is, we believe, the only vacuum cleaner designed so that it may be carried by means of a strap over the shoulders, thus leaving the hands free to manipulate the nozzle. The arrangement also permits of its being

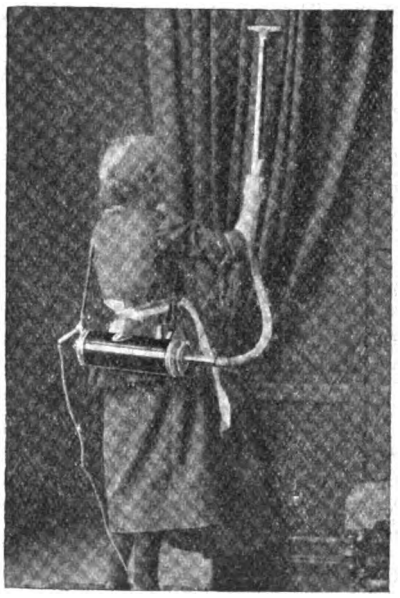


FIG. 1.

used for cleaning carpets and other floor coverings in the usual way. It is thus more convenient to use than the large bellows machines, as the radius of action of these is limited by the length of hose. The illustrations show clearly the machine in use, and as nozzles are provided for cleaning curtains, upholstery, woodwork, book-shelves,

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leather, as well as floor coverings, etc., it is difficult not to appreciate that its novel construction embodies many points of utility and convenience. The motor suction fan



FIG. 2

and dust-bag are all housed in the small metal cylinder. A new illustrated booklet, entitled "Clean Your House the 'Electrolux' Way" has been issued by the Z Electric Lamp and Supplies Co., Ltd., who are also demonstrating the cleaner in their showroom at 73, Newman Street, W.1.

THE EDUCATION OF THE APPRENTICE.*

By J. MARSHALL BELL.

(*Concluded from page* 386.)

DISCUSSION.

The Chairman said he was sure he voiced the feeling of the meeting when he said that Mr. Bell had given them a most interesting and enjoyable paper. He thought it would be premature to ask them to discuss the paper or to criticise it at any length. Personally, he might say he was in full agreement with the suggestion of keeping a record of children as proposed by Mr. Bell. They often found a boy had been apprenticed to a trade for which he showed no aptitude, and it was important to remember that a bad tradesman was not so good as a good labourer. Under present conditions, they never knew how an apprentice would turn out, for they had no records of his bent during the final years of his schooling. During the last two years of a boy's school life, he thought a properly kept record of his inclinations and his ideas would be very useful. Such a system, he thought, would be in the interests of the boy, in the interests of his parents, and in the interests of the nation generally. It would be an advantage to get the lads to attend night schools. They generally found that if an evening class opened with 20 pupils, the number after the Christmas holidays was down to 10, and at the end of the session the instructor was lucky if he had any left. He admitted that outside inducements exercised a great attraction, but he did not exonerate the parents from blame. The parents should point out to the boy in a proper manner the necessity of obtaining a good education. He would not say more that evening, but in particular he welcomed the suggestion that employers should be furnished with a proper record of the inclinations of their prospective apprentices, as under the present system they were working under great disadvantages.

Mr. M. Dempster associated himself with what the Chairman had said about the excellence of the paper. The issues of the whole question had been prominently brought before them in a refreshing and convincing manner. He heard of a case where as an apprentice a boy came who held all the higher grade certificates. Before he got them he was 18 years of age. He could not get them any earlier. He was also a gold medallist. When he came he was put into the office to spend six months in learning office routine. But what did they find? The boy could not deliver a message properly. Another boy, who had got through his examinations by the skin of his teeth, was worth a dozen of the gold-medallist boy. Finally the boy's parents were sent for, and it was explained to them that they had crammed the boy to such a state that they had driven common-sense out of him. He had become stupid with too much education.

When America came into the war she began to build up her army on a new system. Every recruit was graded in respect to intelligence: the first grade was composed of those possessing a highly developed intelligence; lower grades were ear-marked for labouring work. The information gained was used in the selection of officers, and the system had worked splendidly. He thought the application of such a system in educational affairs would be a great advantage. Employers would then receive definite knowledge of the boy's peculiarities, capabilities and qualifications, and the boy's chances of advancement would be materially improved.

Mr. A. T. Paterson.—The education of the child and of the apprentice was a very difficult one, and was a subject upon which much had been written. He would not go so far as some and lay the blame entirely on the teachers. It was the system that was at fault. Greater attention should be paid to the individual characteristics of the child. In regard to night classes for apprentices, there was a considerable number who would never be any the wiser by attending classes, but who yet might be quite good workmen at the bench handling material. Others, again, could take advantage of a good technical education, and these should retain the principles of their work and trade in their minds. Some boys went to a night school simply because they felt their foreman would be adverse to them if they did not go, but they were none the better for it. In many cases, classes would not help the general worker. Such workers should be educated to do a job worth looking at; to take a pride in their manual work and its outcome. This should be done by special training in the workshop.

Mr. W. Cairns said he considered that the opportunities for additional education were not lacking to-day as in the past. He agreed with the Chairman that the fault often lay in the fact that the boys were put into a wrong trade, into a trade unsuited to their capabilities. Regarding night schools, they would always have only a certain percentage of the boys coming out on top, for the simple reason that not all the boys were suited for the higher posts. He thought the pleas submitted at the end of Mr. Bell's paper were very notable, particularly 5, 7 and 8. He thought it a particularly good suggestion that there should be closer co-operation between employers and the educational authorities.

Mr. J. Black felt that he would like to study the paper before saying anything about it. One could only talk from one's experience. He had had an excellent experience in that as a lad he was kept at school until 17 and then apprenticed to an engineering firm of standing in Newcastle-on-Tyne. He could not say how he was induced to attend evening classes. The evening classes provided were of a very high standard, all the instructors being professors. Practical subjects were not taught unless they actually had the necessary apparatus. Similar circumstances did not exist in Fife to-day, except at Cowdenbeath. In the Buckhaven district some of them had been trying hard to edu-

* Paper read December 17 before the East of Scotland Branch of the Association of Mining Electrical Engineers.

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cate the educational authorities themselves on the necessity for providing material to enable practical demonstrations to be given. The failure to make suitable provision was due not to lack of funds but to a lack of driving energy. £4,000 had been spent on certain equipment but that merely touched the fringe of the subject. At Newcastle even at that time—he was speaking of a good many years ago—they had a modern type of engine and apparatus to test the development of horse-power and other machinery, provided gratis by certain firms in the district. At that time, where would they have got a technical centre like that of Newcastle? Other firms were now alive to the value of a good technical education, and the Westinghouse Company had organised a system of classes. As an Association they should get the educational authorities to link up evening classes with special practical instruction in the workshops in the district. He hoped the Association would make a practical and sustained effort until they succeeded in linking up the educational authorities with the employers. The effort would need a lot of driving force, but he hoped they would make the effort.

Mr. J. Turner thought the influence of heredity and environment should be taken into consideration as regards the adaptability of the child. The present system of education was often too rigid in its methods. For instance, the answer to arithmetical problems was only accepted if reached by a certain method. He thought the method of arriving at a desired result was immaterial provided the child understood the problem. In the workshop the same idea should apply. An apprentice should not do a certain thing in a certain way merely because he had been told to do it that way. He should understand why certain results were obtained from certain actions. In dealing with apprentices the key note of their instruction should be "Get understanding." If they had understanding they would never stick.

Mr. B. Mead said the paper was a real guide to its subject. The education of the apprentice was a difficult question, for very often the apprentice was the "boss." They found colliery companies putting down an extensive generating plant, and then putting in any incompetent person to drive it. He commended Mr. Bell's proposal that methods of suggestion should be used in the education of the child, while he also agreed in his condemnation of learning parrot-wise.

Mr. James Dawkins.—In this matter they should consider, as well as the employers' view, the view of the apprentice. The apprentice was often trained in only one branch of the work of his trade. For instance, they would find a man who was a good armature winder but theoretically he knew nothing about it, for the simple reason that in his apprentice training he never learned the theory of the armature winding. The best armature winder was made by one who had had an all-round electrical training in a large works as an odd repairing man. Often the boy did not get practical training. He was taught to repair a job, but he was not told how the fault was caused. In Fife they had two big colliery companies. Why could not they, as an Association, get classes started to give the apprentices practical ideas? They came to the branch meetings and heard various papers. Some were of value to the managers but of little value to the electrician; other papers were of value to the electricians but of little value to the managers; to the average apprentice the papers were often of no value whatever. The time was opportune for the establishment of special classes to give the apprentice training in practical work. The present night schools, he thought, were of no value whatever to the apprentices. There was too much talk about electricity and no practical work. He pressed strongly for the Association taking up the matter. If they could show the apprentices that they were going to give them practical ideas they would get a house full.

Mr. M. H. Forrest said it was all very well to talk, but how were they, as an Association, going to get the suggestions made put into practice? In the training of the apprentice he thought the most necessary thing they required to do was to instil interest in the apprentice himself. Unless an apprentice took an interest in his work he would make nothing of opportunities provided to advance his training. He supported Mr. Dawkins in the demand that the Fife and Wemyss Coal Companies should conduct classes in practical instruction.

The Chairmn said that, the evening being well advanced, they would have to postpone hearing Mr. Bell's reply to the discussion until the next meeting.

THE "COSMOS" RADIANT FIRE.

The "Cosmos" radiant fire, illustrated below, has a substantial cast-iron base finished in black enamel. The general design of the heating element, it will be seen, is that of a grooved cylinder of refractory material on which the resister is wound, the whole quickly attaining red heat. It is fitted with plug contacts and is therefore quickly and easily removable, as is the protecting wire guard which fits on the rim of the copper reflecting bowl. It is an advantage in being able to remove the element as well as the guard in order to clean the reflector—a simple operation which should be performed frequently enough to keep the copper



surface bright if the maximum effect is to be attained. The swivel and trunnion movement allows of the heat beam to be directed where required, but it will be noted that the manufacturers, the Metropolitan-Vickers Electrical Co., Ltd. (Trafford Park, Manchester), do not advocate this type of fire for cooking operations, which are precluded by the design of the guard. A disadvantage, in practice, of the use of these fires for cooking operations being that the element is exposed to the risk of burn-out by food dropping on it, and at the same time liquid may be spilled or boiled on to the reflector, thereby reducing its heat-reflecting value. The terminals of the "Cosmos" radiant fire are protected by round pressed steel guards, the weight is about 7 lb., and the energy consumption about 550 watts.



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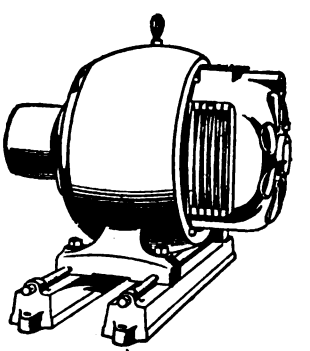
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Current Topics.

Now that the coal strike has concluded and the engineers have thought better of it, it is to be hoped that the cost of coal and the engineering products, which so largely depend upon cheap fuel, will speedily resume a more normal level. I referred in my last week's notes to the German competition for a Sheffield contract, but there is an even worse record from down under. Tenders were invited some time ago by the Victorian Government for a large portion of the electrical installation comprised under the general heading, transformers and switchgear, required by the State electrical works for use in connection with the supply of electrical energy generally. Only three tenders were received for the whole of the plant, but there were several for various portions, including some British quotations. The contract has been allotted to the International General Electric Co., of U.S.A., whose tender amounted to £379,000 and included favourable delivery.

High Prices.

It was stated that the Electricity Commissioners had exhaustively examined the British tenders, and, after taking the lowest price for any separate item of the whole plant from any one of them, it was found that the total resultant price would then amount to £680,000, or £301,000 more than the successful U.S.A. tender. It was also officially stated that the preferential tariff in favour of British goods, coupled with the rate of exchange with America, had been fully considered, and even taking these factors into account there was a saving of at least £200,000 between a selection of all items from the lowest British quotations and the lowest individual U.S. tender. Neither patriotism and regard for the Mother Country, nor common sense can stand against such unfavourable competition, and the result has been to discredit British enterprise in Australia.

When criticism comes from a highly placed official who has had actual experience of a large organisation from the standpoint of one of its highest staff appointments, there is usually some good cause for such criticism. Giving evidence before the Select Committee on the condition of the telephone service, Lieut.-Col. O'Meara, formerly Engineer-in-Chief to the Post Office, gave as his reason for relinquishing the post the fact that he could not achieve any useful work in the organisation as it then was. He had come to the conclusion that the Department's methods were fundamentally wrong. He attributed the main defects of the system to the attempt at combining under the direction of a single permanent head, the Secretary of the Post Office, three such diverse undertakings as the Post Office Savings Bank, the postal service, and a highly technical business such as the telegraphs and telephones. Other contributory causes were the over-centralisation of control, and considerable duplication of work, the poor status of the technical officers, and the failure to recruit for the engineering department men of sufficiently high technical education and attainments. In general, he advocated the separation of the telephones from the Post Office, and their administration by a board as in Sweden.

Inside Knowledge.

It is reported that as a result of the active development of the water powers of Ontario by the Government of that Canadian Province, the leading municipalities are able to sell electrical energy to manufacturers at rates ranging from £4 to £5 per horse-power per annum. Although there are no coal mines within the Province, Ontario has become, as a result of this cheap power supply, the leading manufacturing Province of Canada. In the absence of equivalent "white coal" in the British Isles, when are the miners going to place us on an equality in the matter of cheap and plentiful electrical energy?

Cheap Electricity and Its Influence.

Similar reports come from Sweden, which actually enjoys a considerable overplus of electricity, and can afford to seriously consider ways and means for disposing of it. According to recent advices, with a view to effective utilisation of the surplus electrical energy generated by Swedish water power and its transmission by cable across the Sound to Denmark, and also with the idea of reducing local costs of production and of providing mutual help in case of emergency, the three largest generating stations in Zealand, at Skovshoved, Kalundborg, and Haslev, have concluded an agreement by which the three stations will be linked up by high tension cables.

It is really surprising what an important influence the choice of suitable and dissimilar metals as pairs for frictional contact, especially where electricity is passing, has upon the design of electrical gear. Contact makers and switches of all descriptions should be most carefully designed if continuous and efficient service is to be secured. Wear, accompanied by electrical arcing and

Friction and the Choice of Metals.

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probably a modicum of electrolytic action, is responsible for many troubles in the electrical switchgear equipment of collieries, where the conditions are about as arduous as one could find anywhere. I was at a colliery the other day, noting the resumed activity following the conclusion of the strike, and incidentally gained the experience which prompts this paragraph.

During my visit certain electrical gear subject to frequent operation developed trouble, and the electrician, in whose company I happened to be, duly conducted an investigation. The fault was traced to certain switches, outwardly of robust design, but which were subject to considerable hard wear and very frequent operation. On removing the covers from these switches, which had only been in service a matter of a few weeks, and that during the strike period, it was found that the heavy rubbing contacts, which were of hard brass, had developed considerable wear—so much so, in fact, that they barely made contact with the complementary springs, which, I believe, were of a harder metal. The switches were by a reputable maker, who, I understand, has since been advised of the incident, and has already taken steps to overcome the defect in design.

Concrete and Electrolysis.

The American Railway Engineering Association, which has been studying the subject of protecting reinforced concrete against electrolysis, has arrived at the conclusion that the most effective method is the use of a waterproof plastic layer of material with petroleum asphalt base or some established waterproofing material free from electrolytes. It is important that the right type of waterproofing material be used on the inside of the protecting shell. The waterproofing pitch should remain flexible indefinitely, should have a melting point in the neighbourhood of 200 degrees Fahr., and be elastic in stretch at least half an inch at a temperature below freezing, and have approximately an inch stretch at 60 degrees Fahr. If the pull be applied gradually the stretch should be approximately six to seven inches at the latter temperature.

ELEKTRON.

THE J. AND P. WIRING SYSTEM.

A catalogue just issued by Johnson and Phillips, Ltd. (Charlton, S.E.7) gives particulars of the J. and P. wiring system. The wires are twin, or three-core, of various cross-sectional areas from .0015 up to .0225 sq. in., rubber insulated and protected by a lead alloy sheath, which gives the necessary flexibility for surface work without tendency to sag when fixed. The fittings are of brass tinned all over and comprise cable-fixing clips, bonding rings, bonding clips, joint boxes, busbars, porcelain connectors, etc. The system is particularly intended for the wiring of domestic and other building interiors without further protection and can be coloured to match the paintwork or distemper so as to be practically indistinguishable from their surroundings.

Fig. 1 shows the smallest fixing clip, Fig. 2 the bonding clip, and Fig. 3 the bonding ring. This is fixed behind the wooden pattrass (specially made to take it), used where connections are made to switch points, etc. It is supplied with four ways, one or more of which may be used as required, and is suitable for cables up to 3/.036 twin core. This bonding fixture is a special feature of the system and enables the work to be effected with great ease. To fix, the tail of the clip is inserted in the slot in the ring, the cable is placed under the clip and the notched end of the latter pushed under the screw. When this is tightened up the cable sheath is securely held both mechanically and electrically.

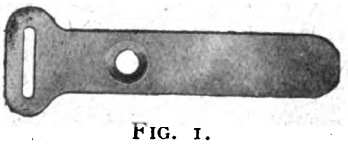


FIG. 1.



FIG. 2.

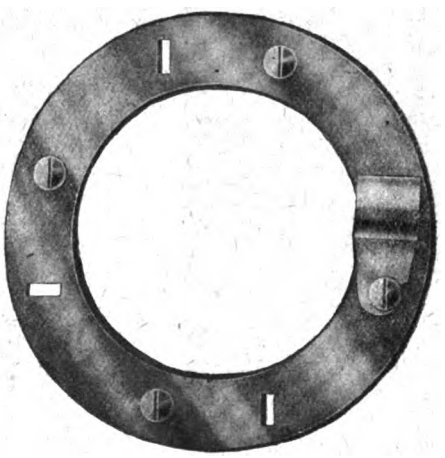


FIG. 3.

The joint boxes and bus-bars are similarly made for rapid erection on the same principle.

Where there is risk of mechanical damage a protective steel covering for fixing over the cables is supplied.

NEW B.T.-H. PREMISES IN MANCHESTER.

It is refreshing, in these days of deep and almost universal depression, to find an electric firm spending money on extensions. This, however, is the wise and happy occupation of The British Thomson-Houston Company, who have recently secured additional premises at National Buildings, St. Mary's Parsonage, Manchester, to take care of their increasing business in that district in connection with the sale of Mazda lamps, fittings and accessories, and to provide greater storage accommodation.

A part of the extension has been tastefully decorated and furnished as a fittings showroom. Here are exhibited a varied assortment of the many novel and effective lighting appliances for which The B.T.-H. Co. have become deservedly famous. These include, amongst others, "Eye-Rest" indirect fittings, semi-indirect fittings, Mazdalux industrial reflectors, X-ray window lighting reflectors, street lighting and other lanterns, and floodlight projectors.

This new showroom constitutes an important addition to Manchester's electrical facilities, of which it is hoped engineers and contractors will take full advantage. Members of the industry in Manchester and neighbourhood are cordially invited by The B.T.-H. Co. to visit the showroom and, should occasion arise, to avail themselves of the advisory services of the engineering staff in respect of any electric lighting or power problems with which they are confronted.

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THE LONDON ELECTRICITY SUPPLY PROBLEM.

(*Continued from page* 391.)

The position has considerably cleared itself during the past week. We referred to the East London scheme in our last issue, the promoters of which have since definitely abandoned the idea of making that area one over which a separate Joint Electricity Authority should be formed. It is now asked that the area in question, being essentially an industrial one, should be constituted a separate district under the management of a District Committee within a Joint Electricity Authority covering the whole area delimited by the Commissioners. Indeed, the promoters of this scheme put it forward as a serious suggestion that the larger area should be split up into four districts, all in charge of independent District Committees, working under the general supervision of the larger Joint Authority. A weak point about the East London proposal, so far as affecting its acceptance by other parties outside, is that a claim is made for financial autonomy, and that nothing should be done by linking up with the outside districts, which would have the effect of reducing the cost of electricity in that district. Linking up is not objected to, as such, but it must be by agreement. At the same time, it is suggested that the larger electricity authority should raise the capital and pass it on to the District Committees, but how the latter can be given financial autonomy in such circumstances has not been explained. The *modus operandi*, so far as administration in the East London District is concerned, is that there should be a Committee of Engineers consisting of the Chief Engineers of the various stations, who would make recommendations to the District Committee, who in turn would submit them to the Joint Authority, and finally, if these three bodies cannot agree, there is to be an appeal to the Electricity Commissioners. That, frankly, involves possibilities of delay and friction, which do not seem to have appealed to anyone outside the providers. The capital station at Dagenham under the East London Scheme would be commenced in time to be useful in 1925-28.

So much for the East London scheme. Next we come to the position of the railway companies. The L.B. and S.C. Co., and the G.E. Co., had deposited schemes, but when it came to their turn, following the East London scheme, a very different complexion was put upon the position. It was quickly announced by the railway companies that they did not intend to proceed with their proposals, such as they were, but they asked to be left out of any scheme that the Commissioners might devise in order that they might be free to obtain their current from the cheapest possible source. As the railway companies still remained parties in the enquiry by reason of having lodged objections to inclusion in any of the schemes, the Chief Commissioner asked them to put in a witness to explain the circumstances. That request drew an even more candid admission from the railway companies that none of their experts had given sufficient attention to the whole problem to be able to afford the Commissioners any assistance. This clearly was not to the liking of the Commissioners, and Sir Harry Haward reminded the chairman of Section 38 of the Electricity Supply Act of 1919, which gives the Commissioners power to order the attendance of a witness. At a subsequent stage, Sir John Snell informed Counsel for the railway companies that the Commissioners desired to see a witness on their behalf. The companies, however, were determined not to produce one, and Counsel for them very firmly, though respectfully, told the Commissioners that they had nobody who would be able to give them any assistance whatever, although, he added, the railway companies would be only too pleased to provide the Commissioners with any information asked for. The position was a hopeless one from the railway point of view, although in general it was still maintained that they could supply themselves more cheaply than if they were to buy their current. Thus the railway companies are cut out of the enquiry, except as objectors on matters of detail.

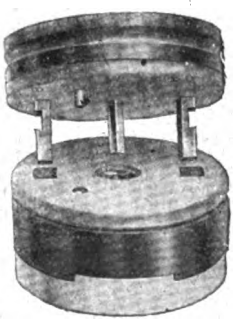
We passed next to the opposition to the four schemes remaining for the consideration of the Commissioners, and the first taken were those of the Metropolitan Electric Supply Co., and the North Metropolitan Electric Power Co. Both are similar, except that in the case of the former the company has a provisional order area in London, which is purchasable by the L.C.C. in 1931. That position it is not proposed to interfere with. Indeed, it could not be. The company, however, has a large bulk supply area in Western Middlesex, whilst the North Metropolitan Electric Power Co., of course, has a similar area in Northern Middlesex and a small one in Essex. In short, both companies ask to be left free from an interference by a Joint Electricity Authority, and urge that there is no need for any other body than the Electricity Commissioners. Indeed, they claim that the large power companies of the country were formed to carry out functions in all or most respects similar to those of the proposed Joint Electricity Authorities. An important point raised was that in the event of the constitution of a Joint Electricity Authority, there would be every inducement for it to enter into competition with the power companies by offering to supply energy in bulk to the authorised distributors in the areas where Parliament has already given the power companies authority to supply, and it is very strongly urged that the power companies should not be put to that risk. Moreover, it was suggested that the existence of a Joint Electricity Authority would seriously hamper the power companies financially, as regards raising capital.

So far as the remainder of the opposition goes, it is not likely to bring out many new points. The Commissioners asked the County of London Co. to put in a witness to deal with the position as regards building capital power stations at once, and postponing their erection until the existing power stations have been extended to their full capacity. The County Co., it should be explained, had an application before the Commissioners last October for permission to build a large power station at Barking—200,000 kw. to begin with, and ultimately 600,000 kw. This they are prepared to do at once, but the Commissioners are withholding their decision on that application until the present enquiry is closed. On the other hand, the Board of Engineers, which has prepared the technical proposals for three of the present schemes, hold the view that it would be unwise to build capital stations at once, and the Commissioners desire to probe this a little more deeply. At first the County Co. did not fall in with the wishes of the Commissioners, their view being that, as their case for the Barking power station was dealt with last October, there was nothing more to say. Later, however, they changed their mind and decided to give evidence.

(*To be continued.*)

"M.-V." SUPER SWITCH PLUG.

The device illustrated below is the "M-V" Super Switch Plug for 10/15 or 15/25 amps., and was designed by the Metropolitan-Vickers Electrical Co., Ltd. (Trafford Park,



Manchester), for use in heating circuits. To switch on, the plug is inserted into the socket and turned to the right; while to switch off, the plug is first turned to the left. Unless this is done it is impossible to withdraw the plug.

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As the plug can only be inserted one way, correct polarity is assured, while a good point is that no live parts can be seen or touched when the plug is either in or out. Further, an earth connection is provided, it has a quick-break and is liberally rated.

THE CHARACTERISTICS OF THE MULTI-SPEED INDUCTION MOTOR.*

By F. CREEDY.

During the last few years it has become very apparent that it is imperative to adopt as far as possible a uniform standard electric power system throughout the country, and the system which has been decided upon is the polyphase (usually three-phase) alternating system. As compared with direct current the polyphase system has two defects to offset its many advantages:—

(1) Wattless currents flow in the mains and reduce their effective capacity for transmitting energy.
(2) Variable speed motors for use on polyphase networks are at present scarcely obtainable.

If and when these two defects can be overcome the polyphase network will be in no respect inferior and in very many respects superior to direct current.

As regards the first, the lines on which a solution is to be sought may be said to be fairly clear. These are the following:—

(1) Large constant speed motors should be synchronous wherever possible. Great progress has been made in designing self-starting and self-synchronising motors, though the number in actual service is still comparatively small.
(2) Phase advancers of several distinct types are available, both revolving and oscillating, whereby induction motors may be made to give leading currents or unity power factors where synchronous machinery cannot be applied.
(3) Electrostatic condensers of large size and thoroughly practical construction are available at fairly reasonable prices.

It may thus be said that the general lines of the solution of the problem of power factor are well known, and the uncertainty as to the proper line of attack has been removed.

With regard to the second problem, that of producing a variable-speed polyphase motor, conditions are very different indeed. The present paper is devoted to describing some of the essential characteristics of a modern type of multi-speed motor, the discussion of the detailed constructions being left for another occasion.

The amount of thought given to the subject in the past has been so surprisingly small that while it is known in a general way that induction motors are sometimes built with two distinct stator windings for different pole numbers, general knowledge on the subject hardly goes beyond this.

In the first place, of course, a multi-speed motor depending on pole changing has only a finite number of distinct efficient speeds corresponding to the different pole numbers. If practicable arrangements of control gear are to be employed the number of speeds available will rarely be greater than six unless perhaps in very large sizes.

It is not so easy to arrange resistance control on a multi-speed motor as it is on a single-speed motor. The reason of this is, broadly speaking, that to change the pole number of the rotor winding involves, as a rule, a considerable number of terminals, and the number of terminals which can be used with a revolving winding is extremely limited, as each terminal, of course, means a slip-ring. It is possible to overcome this difficulty, but its existence gives a strong incentive to the use of a machine with a short-circuited rotor wherever possible. It is possible with comparative ease, however, to arrange a multi-speed motor to give resistance control on one speed only, which may with advantage be the top speed. The process of changing speed will then be as follows:—If we assume that the motor is controlled by what may be described as a "selective" type of controller such a contact or panel, in which it is possible to change from one speed, such as the top speed, to any other without passing through the intermediate speeds, this can be done on a contact or panel, the maser controller of which consists of a number of independent switches, one corresponding to each speed, suitably interlocked so that not more than one switch can be closed at once.

The operation of such a controller in conjunction with a multi-speed motor having resistance control on the top speed is as follows:—The speed is regulated from the top speed downward by means of the resistance until a speed corresponding to a higher pole number has been reached. This having been done, the pole number can be changed from that corresponding to top speed to the lower speed desired by an instantaneous operation on the contactor board, the resistance being automatically cut out of circuit at the same time by the inter-connections of the rotor winding. This is accomplished by so arranging the secondary winding that points between which resistance is connected on the top speed become equi-potential points on the lower speed, so that there is no tendency for currents to flow through the resistance. Such a type of control has a wide field of usefulness, but it does not entirely supersede the necessity for genuine resistance control on all the speeds.

It should be noted that this last type of control in modern installations has two distinct functions:—

(a) To permit starting and speed changing without a shock to the system caused by switching over suddenly from one speed to another.
(b) To permit of the use of phase advancers on all speeds.

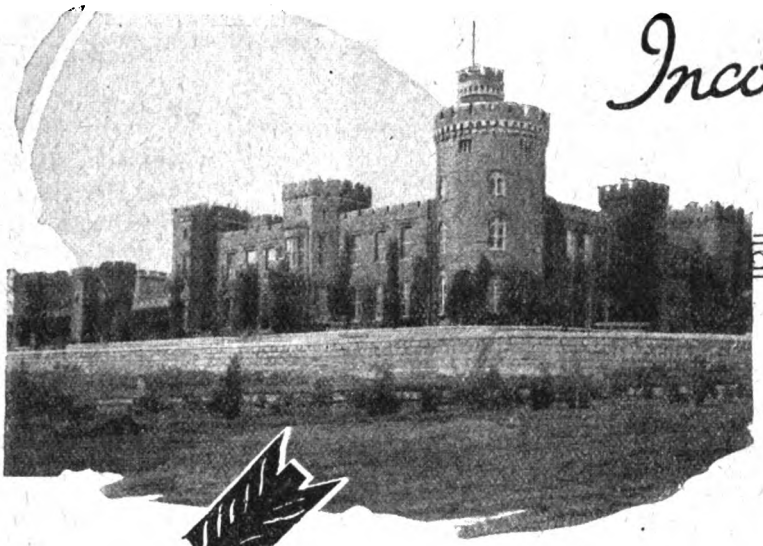
This latter point is becoming of greater importance every year. As the writer has often pointed out before in various publications, large motors are more usually required to be of the multi-speed type than small ones, since the large motor usually supersedes an individual steam engine with its excellent variable speed characteristics, which are largely made use of in practice, while the small motor frequently replaces line shafting, which is necessarily operated at constant speed. Hence the phase control of these large multi-speed motors is not a subject that we can lose sight of in the future, although very little is being done towards the solution of the problem at the present time.

Much, however, may be done with motors having purely short-circuited secondaries, particularly if the step between speeds is not too great. In this connection attention may be drawn to the recent development of hydraulic and other clutches which permit of the starting and speed changing of motors on no load, the load being gradually applied by means of a clutch. Such a device may in many cases form an efficient substitute for slip-ring control.

Being well aware of the importance of the subject, the writer carried out a careful series of experiments with regard to the rush of current which takes place on changing the speed of a motor with short-circuited secondary, both on no load and full load. These experiments were conducted on a 70 h.p. machine built by F. and A. Parkinson, Ltd., Guiseley, with a view to studying the kick of current when changing from one speed to the next both on full load and no load. A special device was fitted to the controller in order to diminish these current rushes. On the step last but one, for instance, the speed is changed from, say, 600 to 750 r.p.m., while simultaneously the voltage on the motor is reduced from line voltage to a considerably lower value. On the next step the voltage is restored to its normal value without any further change of speed. In this way it was believed that these current rushes could be reduced, and a careful series of tests was taken on this point. These showed that the effect of the device

* Abstract of Paper read before the London Branch of the Association of Mining Electrical Engineers, and printed in full in *The Mining Electrical Engineer* for May.

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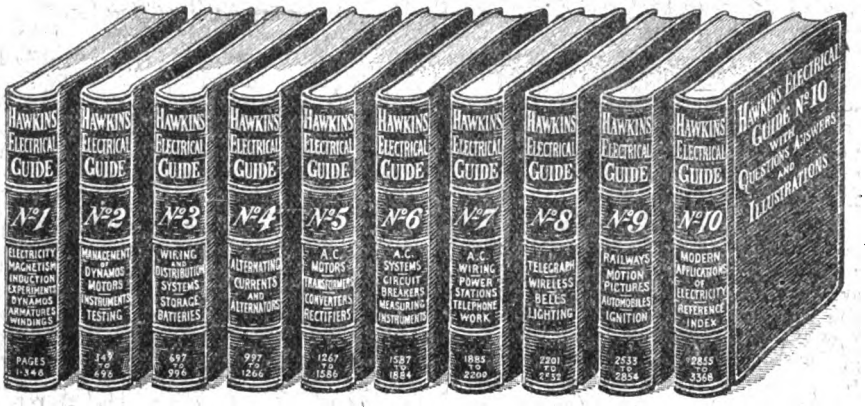
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just described is distinctly noticeable, and that the higher peaks of current are thereby cut off, the maximum current kick being reduced from about 2.4 times full load to 1.75 times full load. When changing speed on low load the current kicks are very much reduced from those obtained on full load.

The chief difficulty which exists with the short-circuited secondary type of single-speed induction motor relates to the starting. This difficulty, however, is almost completely overcome with the multi-speed motor having any considerable speed range, for reasons which it is hoped are made clear below. We may assume that a two-pole and a four-pole case in which the air gap density of a motor is the same, and therefore the magnetising current taken by the motor remains constant independently of the number of poles: the quantities determining the total magnetising volt amperes depend only on the maximum air gap density, frequency, and area of the gap surface, and not at all upon the number of poles or any other feature of the winding. But in one case there are four conductors connected in series, each lying in the middle of the pole surface, and in the other only two such conductors. If, therefore, we send the same current through the four conductors as through the two conductors, the densities of the fields in which they lie being the same in each case, then in the four-pole case we obtain twice as much torque as in the two-pole case, or, alternatively, for a given torque we only require half as much current in the four-pole case as in the two-pole case. Hence, if we can arrange a motor so that it starts on four poles and runs on two poles, it will require only half the starting current to obtain a given starting torque that it would require if it started with two poles. However, if a machine is arranged for two-pole and four-pole only, the effect of such a method of starting will merely be to transfer the heavy rush of current characteristic of the starting of a short-circuited secondary type of induction motor from the moment of starting to the moment of changing speed from four-pole to two-pole, so that the real benefit is not very great.

If, however, we are enabled to introduce a number of intermediate steps between the starting pole number and the running pole number, this current rush at changing speed may be very much reduced. For instance, if we start with 16 poles, and instead of changing over directly to eight poles for running purposes we change from 16 to 14, 12, 10 and 8 in succession, the current rush will be reduced to very moderate proportions. As a matter of fact, the starting performance of this machine (the 70 h.p. machine referred to above) on the step corresponding to 16 poles was .775 times full load torque with 1.88 full load current, whereas, had it been started at the top or 8-pole speed, it would have required at least four times full load current to give the same torque. Further corroboration of these facts with regard to the starting torque of such machines may be derived from some curves relating to three-speed motors of a smaller size, e.g., the calculated starting performance of a 15 h.p. three-speed motor arranged for four, six and eight poles gives, with the eight-pole connection, 1.7 times full load torque with twice full load current; with a six-pole connection, 2.3 times the full load torque with 3.5 times full load current; and with the four-pole connection, three times full load torque with 8.6 times full load current.

Two types of multi-speed motors exist according as we arrange the field strength to be constant on all speeds, in which case we get a motor giving constant torque at all speeds, and therefore a h.p. proportional to the speed; or a field strength inversely proportional to the speed as in the direct current motor, in which case we get a similar rating, namely, constant h.p. at all speeds.

For the majority of applications the constant torque motor presents a very notable advantage as compared with the direct current motor which, as just pointed out, will give no more h.p. on the highest speed than it will at the lowest, while the characteristic of almost every type of industrial apparatus is such as to require greater h.p. at the higher speeds. Thus the natural characteristics of the constant torque motor correspond much more closely with those of ordinary industrial machinery than do the characteristics of direct current motors.

(To be continued.)

HYDRO-ELECTRIC ENERGY FROM THE RHONE.

A French company has obtained a Bill authorising them to develop the water-power of the Rhone, and thereby to save (according to M. Le Trocquer, French Minister of Public Works) 6,000,000 tons of coal a year.

The new scheme will mean the development of an additional 1,100,000 h.p. Eighteen power stations will be erected at suitable points along the river, the largest at Benissat, which will produce 250,000 h.p. The chief users of the new supply will be the city of Paris and the Paris, Lyons, and Mediterranean Railway. It is proposed that all the railway lines within the quadrilateral Bellegarde, Lyons, Marseilles, and Vintimille should be electrified. This is, of course, a comparatively simple task; but the use in Paris of electric power generated at Benissat and carried over a distance of 280 miles is a much more formidable undertaking. It is proposed that the power should be transmitted to Paris by six cables through two main feeders, one passing by Dijon and the other by Nevers. In the words of M. Le Trocquer, this enterprise will be the greatest, from an economic point of view, ever undertaken in France.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

ELECTRICITY IN STEEL WORKS. By Wm. McFarlane. 112 pp., 21 figs. (Pitman, 2s. 6d. net.)—Electrical engineers interested in steel mills, and students, apprentices and others in the steel trade will find in this review of current electrical practice in iron and steel works a concise and clear account of the extent to which electricity has been applied with success. The problems of generation in relation to the efficient utilisation of the waste heat are considered, as are the peculiar problems met with in the driving of reversing, three-high, bar and sheet mills, etc., the case of control and general merits of both A.C and D.C. coming in for investigation. Control gear is carefully dealt with and an insight into the question of the design and use of lifting magnets for all steel works purposes is given, and to render the volume complete we find that the use of "auxiliary" motors and the important question of artificial illumination are treated. Seeing that the electric motor found little favour in steel works in any country till the beginning of the present century, the progress recently made has been very rapid and is destined to continue at an accelerated rate in the near future. The problems involved, however, still require much consideration before finality in the design of the electrical gear is reached.

THREE-PHASE INDUCTION MOTORS. By L. E. Wood. 130 pp., 72 figs. (*Elec. Review* 6s. 6d. net.)—This "'practical aid' to those who have under their care the running, maintenance and repair of three-phase induction motors and have neither the training nor experience necessary to deal with the many practical problems that arise from time to time" starts badly, but on the whole improves towards the end. It contains much sound information concerning the maintenance and repair of induction motors as well as the question of starting, but,

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although the author belongs to the school which believes that "so long as the practical man understands the rudiments of the principles on which motors operate, that is all he needs," he finds it necessary to embark occasionally into the realm of theory. Without a proper understanding of the subject, however, it is certain that our "practical" man will only get confused especially as in a large number of instances loose or inaccurate statements are made, e.g., it is stated that it is necessary to keep the air gap as small as possible, so that the *energy loss* shall be as small as possible. He is also introduced to the mythical "saturation point" and is left with the impression that at a certain load the electrical losses suddenly jump up to a very high value. Again, what is the use of this statement by itself: "The most serious disadvantage of the squirrel cage motor is its low starting torque, being about 75 per cent. of full load torque"? As a final example might be cited the reference to switching a motor directly on the line where it "may start under the minimum amount of friction . . . and the capacity of the plant is such as to have little or no effect on the regulation of *same*, motors up to 25 h.p. may be started in this manner." It is a pity that there are many such misstatements and ambiguities, as the bulk of the letterpress is useful while, although well sub-divided and displayed, it would greatly benefit from an index.

Various Items.

Books for Sale.—A reader is anxious to dispose of a set of eight volumes of "The Cyclopædia of Applied Electricity." For particulars see a prepaid advertisement.

Change of Address.—Mr. David G. Brooks, representing the Walsall Hardware Manufacturing Co., Ltd., has moved from 79, Lincoln's Inn, Corporation Street, to Daimler House, Paradise Street, Birmingham.

Educational.—Readers who are thinking of improving their knowledge of our science during the summer should make a point of writing at once to Dept. 11 of the Bennett College, Sheffield, stating the subject which they wish to work up. They will have every attention given to their inquiry.

Benevolence.—The Electrical Trades Benevolent Institution has received a cheque for £76 4s. 2d. from the Cardiff Local Advisory Committee, this being the proceeds of a whist drive and dance organised by the local branch of the Electrical Contractors' Association, held on March 4, 1921. More please!

A.M.I.E.E. Examination.—It is proposed, if a sufficient number of candidates make application, to hold an examination for associate membership in London and at other places (at home and abroad) in October, 1921. An entry form and full particulars may be obtained an application to the Secretary of the Institution, Savoy Place, Victoria Embankment, London, W.C.2.

Spain.—A company has been formed at Granada under the name of "Sociedad Anonima Fuerzas Motrices del Valle de Lecrin," with a capital of five million pesetas, who intend erecting and working hydro-electric power stations in the Valle de Lecrin. It is proposed to erect the first station on the river Durcal, where a drop of 758 metres and 4,000 h.p. will be utilised. It is hoped that English firms will do their best to obtain the orders for plant.

Personal.—Mr. A. Hugh Seabrook, M.I.E.E., M.I.M.E., a former manager of the West Ham Electricity Station, and who now has a large practice in the City as a consulting engineer, has joined the Board of the Barndon Power and General Electric Company, Ltd., of Stratford, as technical director.——At the last meeting of the committee of the Association of Consulting Engineers, Mr. W. Vaux Graham of 5, Queen Anne's Gate, Westminster, S.W.1. was unanimously elected chairman for the ensuing year.

New Zealand.—H.M. Trade Commissioner reports that the Sec. of the Public Works Tender Board, Govt. Buildings, Wellington, will receive tenders until noon of Nov. 1 next for the supply, delivery and erection of new or second-hand auxiliary plant for the Rotorua electric supply as follows:—One oil engine 200 to 250 b.h.p. One 3-phase 50 cycle, 190 k.w. alternator, at power factor of 8, complete with exciter and switchgear. Specification, etc., may be seen at Room 59 of the D.O.T., 35, Old Queen Street, S.W.1.

Preston.—At a special meeting of the T.C., a resolution was approved authorising application to be made to the Electricity Commissioners for an Order enabling the Council to supply and distribute electricity throughout Preston, Fulwood, Broughton, Lea, Ashton, Ingol and Cottam, Woodplumpton, Barton and Penwortham, and to empower the Council to purchase the National Electric Supply Co. The Mayor said plans for a new generating station would be prepared, so that there would be no delay when the Order was received.

Transport Exhibition.—From Nov. 17 to 25, a Public Works, Roads and Transport Congress and Exhibition, at the Agricultural Hall, Islington. Amongst the exhibitors appearing in the preliminary list are British Electric Vehicles, Ltd., Edison Accumulators, Ltd., Electro-Metals, Ltd., General Vehicle Co., Ltd., Hadfields, Ltd., Ingersoll-Rand Co., London Warming Co., Ltd., Rawlplug Co., Ltd., Robey and Co., Ltd., Stevens Petrol-Electric Vehicles, Ltd., Stothert and Pitt, Ltd., etc. Full particulars may be obtained from the Organising Manager, Mr. A. F. May, 13, Victoria Street, S.W.1.

Electrical Connections, Graphs, etc.—We have received from Claude E. Mayer (18, Geoffrey Road, Brockley, S.E.4) a blue sheet containing diagrams of connections and formulæ for the location of faults, measurement of E.M.F. resistance, capacity, inductance, power in A.C. circuits, etc. Mr. Mayer, who has had 18 years' experience in shops and d.o., is open to prepare technical drawings and designs, to perform calculations, work up ideas, etc. The blue sheet referred to is one of a series of four "charts of technical data for shops and d.o.," supplied at the price of 1s. each post free.

Proceedings of the Inst. of Railway Signal Engineers.—The eight annual report (1920) shows steady progress in every branch. There are now 305 members. Included in the "Proceedings" is the paper and discussion on "British Railway Telegraphs, France, 1914-19," by Capt. M. G. Tweedie; the result of a discussion on "Track Circuit Nomenclature"; and a paper and discussion on "Some Problems of Track Circuit Lay-out" by W. C. Acfield. The author points out that in all cases protection is required against rear collision, fouling point collision, and end-on collision. He then deals with the design of roads and sets out 18 track circuit problems, which are fully discussed. The price of the volume is 5s. Capt. M. G. Tweedie, Signal Dept., G.W.Rly., Reading, is the hon. sec.

Trade Notes.

Simplex Conduits Ltd. (Garrison Lane, Birmingham), have issued an enlarged and revised edition of list No. 861, dealing in detail with the Simplex Colliery Lighting System, described in ELECTRICITY, April 8, p. 205.

Meldrums, Ltd. (Timperley, near Manchester), advise us that they have recently received orders for oil fuel burners for the Bangor and Altrincham electricity depts., and send us a leaflet describing their portable "Sack" steam-disinfector for soiled and infected clothes, surgical dressings, etc.

A leaflet from the **G.E.C.** describes and prices "Fairyland" strip—lighting cable with lampholders placed at equal distances, for indoor and outdoor illumination. The lampholders are either B.C. or E.S. as required, and the whole arrangement is made specially watertight for permanent outdoor use if desired. Various devices are also listed for use with the strip.

The **Edison Swan Electric Co., Ltd.,** inform us that their Cardiff branch office has been removed to larger premises at 25-27, Charles Street, and in order to make for better efficiency and service to the trade, the branch is now in direct touch with the company's works, instead of being a subsidiary branch working from Bristol. Mr. W. Elliott, B.Sc., A.M.I.E.E., has been appointed superintendent of this new district.

Daniel Adamson & Co., Ltd. (Dukinfield, Manchester) are issuing a booklet in which they outline the achievements of the founder of the firm and trace their contributions to heavy engineering science and manufacture. The present large and well-equipped works have grown from the Newton Moor Ironworks, established by the late Mr. Daniel Adamson, in 1851. At the present time the company manufacture all kinds of turbo-plant and auxiliaries, super-heaters, water cooling plant, compressors, steam engines, boilers and boiler-house details, steel plate products, etc.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
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JULY 29, 1921.

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"EDISWAN" HOUSE WIRING SYSTEM.

A house wiring system possessing some unique features is now, after much careful thought on the design of the component parts, which, by the way, are reduced to what would appear to be an irreducible minimum, just about to be placed on the open market by the Edison Swan Electric Co., Ltd. The cable used is manufactured by the Enfield-Ediswan Cable Works, Ltd., especially for use in the system. It is of the usual kind for house wiring, and has a metal alloy sheathing of the necessary flexibility for surface work. It is supplied in standard lengths of 110 yards, on small flat drums as follows:—Single .044 in., 18 S.W.G. and 3/22 S.W.G.; Twin .044 in., 18 S.W.G., 3/22 S.W.G. and 3/20 S.W.G.

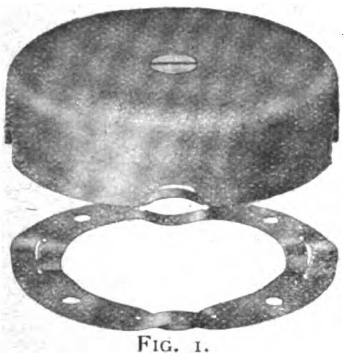


FIG. 1.

One characteristic feature of the system, however, is the bonding ring, for the purpose of connecting together the metal sheathing of the cable at all ceiling roses, switches or other fittings. It consists of a ring of soft tinned brass in which there are four slots, the sides of which are formed so as to allow the metal-covered cable to pass through (see bottom of Fig. 1). The outer and inner diameters of the bonding ring are the same as the outer and inner diameters of the block, and the blocks (see top of Fig. 1) are supplied with grooves to fit the bonding ring and cable. When the block is screwed down in the ordinary manner, the cable is gripped on both sides by the bonding ring, thereby effecting electrical contact. No small screws and nuts are required: the necessary bonding is obtained simply by screwing down the wood block by means of the usual wood screw through its centre. It is always possible when inspecting the completed work, to see whether the bonding ring has been properly inserted, as the edge and the turned-up portion are visible at the sides of the block.

For back-entry, instead of inserting the cable itself through the slit in the ring, a wing of lead should be turned back from the cable and inserted in the slit in the ring. A plain block is then used, and, when screwed home, presses the lead and ring tight together. If there are both side and back-entry cables to the same block, a block with the requisite number of grooves for the side-entry cables only is used, and the spare ways in the bonding ring are employed for gripping the lead of the back-entry cables.

The bonding rings are suitable for any of the cables referred to. Three of the four slots are of equal width, and the fourth is slightly wider. The smaller slots will take one twin or two single cables. The larger slot is intended for a twin cable with a single wire in addition (for looping-in connections) or for three single cables. The bonding ring is thus "universal," and any ways not utilised are automatically pressed flat when the block is screwed home.

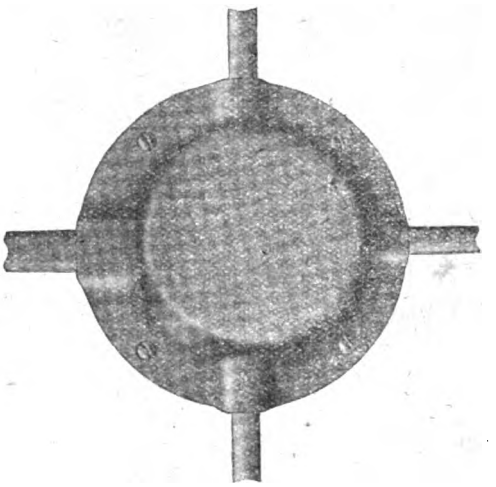


FIG. 2.

The wood blocks are supplied grooved to take the cable, and in two finishes: imitation walnut and white enamel. They are 3½ in. diameter—the standard for the usual patterns of switches and ceiling roses—the internal diameter is 2⅜ in., and the thickness 1 in. As the bonding ring does not occupy any space in the interior of the block, there is ample room for cable slack: the block grips the cable so tightly that it cannot pull back after the block is fixed.

The 4-way block is put forward as "universal" for surface work, as all the ways need not be occupied, and many wiring firms may prefer to stock this size only. It is grooved to take one twin, or two single cables. The grooves in the 2-way and 3-way blocks are of the same size, and the single-way looping block will take three single cables, or a twin and a single side by side. If, for any special work, larger cable or more cables per way are required, the groove may be eased with a half-round file.

There is a maximum of free space within the block to encourage the wireman to leave plenty of slack behind the block. Insulating safety bushes are supplied. Their use is not in any way necessary, but they introduce an additional safety precaution at practically a nominal cost. They are provided for slipping over the centre screw if it may be thought that there is likely to be any risk of the cables being damaged.

The junction box is made in the form of a universal 4-way box. Three of the ways are for two single or one twin cable up to 3/22 S.W.G., and the fourth way is slightly larger to take a 3/20 twin cable, but will nevertheless clamp effectively twin or two single cables of

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smaller size. The box is neat and symmetrical in appearance, and any of the four ways not required may be left spare. It consists of a heavy iron backplate, a bonding ring, a porcelain connector, and a substantial stamped iron cover, painted grey. In fitting, the backplate is screwed to the wall by means of a screw through the centre, the cables are then passed through the bonding ring and connected as desired by means of a porcelain connector having the number of ways desired, and the cover is screwed on by four round-headed iron screws provided with the box (Fig. 2).

As in some cases it may be more convenient to use the backplates and bonding rings separately behind standard wood blocks, and in other cases the backplate may be dispensed with and the cover screwed direct to the wall, backplates and covers are supplied separately, if desired.

The cables are clamped between an iron backplate and a thin tinned brass strip, which ensures good contact. The backplates are thick, and there is no risk of the thread of the screw stripping when screwed home. The earthing wire should be inserted between the brass strip and one of the cables before screwing up, or (preferably) soldered to the brass strip. These bonding strips (Fig. 3) are made 2-way, 3-way, and 6-way, each way taking two



FIG. 3.

single or one twin cable of any of the sizes already referred to. If a larger cable has to be bonded up, one screw can be left out and two ways used as one.

Lead is admittedly the best material for fixing cable to the walls of buildings. As it is softer than the sheathing of the cable, the cable itself cannot be damaged, and there is also no risk of corrosion. Just because of the softness of lead, however, it has generally been found troublesome to use it for this purpose, and various forms of tinned brass or iron clips are employed.

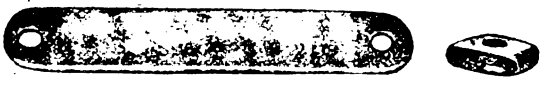


FIG. 4.

In the "Ediswan" wiring system the cable fixer consists of a lead strap, which is passed round the cable, a bronzed cap fitted over the ends, and the whole nailed or screwed to the wall or ceiling. The cable is thus securely held without any possibility of the head of the nail or screw being pressed against it: there are no projecting edges of metal and the minimum time is occupied in fixing. The lead strap and bronze cap are seen in Fig. 4, and in position round the cable in Fig 5. For vertical runs and on ceilings, the straps should be used with the heads on alter-

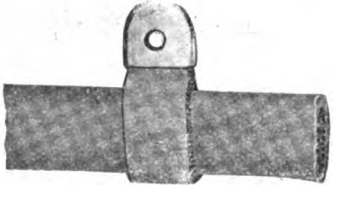


FIG. 5.

nate sides of the cable to secure the firmest fixing, or the strap may be used as a saddle with a cap at each end. The standard lead straps will take two single cables or one twin. Boxes of cable fixers contain 144 caps, 100 lead straps and 10 ft. of lead strip, so that a longer piece of lead strip may be cut off and used in place of the standard strap for more than two conductors.

From personal inspection and demonstration we are of the opinion that the "Ediswan" wiring system makes a very neat job, the component parts being well designed and made almost entirely at Ponder's End and the remainder elsewhere in England. The bonding obtained is good and is effected without trouble, whilst the bonding ring, wood blocks, junction boxes and cable fixers are items of marked utility—applications for patents in respect of the last three have been made. The system should be erected very quickly and by full use of the 3-plate ceiling rose, the minimum number of wires is required to give maximum control.

THE USE OF WATER POWER IN NEW ZEALAND.

BY ELLACOTT GENNER

Although New Zealand is, comparatively, a new country, the use of the most modern methods in her national life, her industries, and her public services is extensive. Particularly is this the case in the provision of power for industrial and other purposes.

The use of electric current has increased steadily during the last few years, and with the rapid growth of her industries and the expansion of her population New Zealand has been wise in exploiting the use of hydro-electric power.

There is abundant water power available throughout New Zealand, both in the North and South Islands, the numerous rivers being short and very fast, few of them being navigable by vessels of any size. New Zealand possesses a great mountain chain of high elevation, which runs through both islands. Lofty passes, from 6,000 to 8,000 feet, intervene between numerous peaks well over 10,000 feet high; extensive glaciers occupy the higher valleys, and the rivers are usually roaring torrents of great volume. In the North Island there are 24 rivers aggregating some 950 miles in length, while the South Island possesses 49 aggregating some 3,000 odd miles in length. In addition there are some two dozen lakes ranging in size from 2¾ to 238 square miles.

Little use was made of this huge water supply until 1900, but since that date the development has been extensive. In 1908 the "Public Works Act" claimed the sole right to the use of the water power of the country and gave the Government the right to develop such power or delegate same to local authorities, companies, or private individuals, subject to certain conditions. These rights were granted free of royalty, except in the case of private individuals, when a royalty of 1-20d. per unit generated was fixed.

The "Aid to Water-power Works Act" of 1910 empowered the Government to establish hydro-electric supply installations, and the first of these is now in operation at Lake Coleridge, 65 miles from Christchurch. The plant was designed for a capacity of 12,000 kilowatts (16,000 h.p.), but the adjacent rivers and lakes facilitate extensions of the supply up to 58,000 h.p. The capacity of the present plant is 8,000 h.p., and the population to be served is well over 100,000.

Another large works is that of the Dunedin City Council on the Waipori River, about 30 miles from the city. The city council laid this plant in 1907 with two units of 1,000 kilowatts (1,340 h.p.), and since that date four more units of the same capacity have been installed, two in 1910, and two in 1913, bringing the total capacity up to 6,000 kilowatts (8,000 h.p.). A total output of 12,991,623 units was sold in the year 1918-19, and a total of 7,858 consumers were supplied.

To date there are in existence 21 supply stations, of which only two are operated by the Government. Fourteen are run by local authorities, and five by private companies. In 1916 there were 42 works in existence as compared with 14 in 1911, while the number of units generated were doubled over this same period. The alternating current system was in operation in 12 cases as compared with 30 of direct current.

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Hydro-electric power is being used more and more each year, and the number of uses to which it is put continue to increase. Apart from the Public Service consumption, including street and general lighting, heating and cooking, ets., power is in use extensively in the mining industry, in flax mills, saw mills, flour mills, for dairying, construction works and factories, freezing works, paper mills, etc. In 1915-16, 61 arc lamps and 8,384 incandescent lamps were in use; general lighting consumers numbered over 22,000, with a total of 654,941 incandescent lamps and 30 arc lamps. Consumers of power for "heating and cooking" numbered 4,485, and a total of 1,490 electric motors aggregating 19,733 h.p. were served. In the same year nine tramways were in operation, seven of which were municipally owned.

As is generally known, New Zealand is rich in mineral wealth, and water-power is extensively used for hydraulic mining, and also to a smaller extent for hydro-electric transmissions for water motors installed to operate mining machinery. There are three large hydro-electric mining transmissions, one of which, on the Waikato River, is a distance of 50 miles from the mines. This installation is the property of the Waihi Gold-mining Company, and the transmission pressure is 50,000 volts, the h.p. being 9,000. Another at Kanieri Forks, the property of a power company by that name, and the other, the property of the Earnscleugh Gold-mining Company, on the Fraser River, near Alexandra. The latter installations are considerably smaller, the first being 675 h.p., and the last 300 h.p. Most of the sources of water supply are privately owned, but the Government has constructed, and is operating, very large water-races for the use of miners on the West Coast and in Central Otago. During 1918, water only was used for sluicing auriferous alluvium at 153 different claims in Otago, Southland, and on the West Coast.

As an illustration of the increasing use of electricity in New Zealand, the following figures may be of interest:—

	Units sold 1910-11	Units sold 1915-16
Street lighting ...	808,167	1,574,827
General lighting ...	2,963,967	8,257,608
Heating and cooking ...	46,903	632,964
Motive power ...	6,294,568	16,313,915

The foregoing gives but a general outline of the extensive, and still extending, use of hydro-electric power, and yet only developed power has been touched upon. The undeveloped power is almost unlimited. There are a large number of available water-powers, from 1,000 h.p. upwards, and a considerable proportion are suitable for general industrial development. The largest supplies are in the South Island, and usually near the deep-water sounds and in the more unsettled portions of the country. With electro-chemical and electro-metallurgical interests close at hand, the supplies, so far untouched, are particularly suitable for the utilisation of these industries, while there are, of course, many other uses to which the power can be put.

LIGHTING BOXES FOR UNDERGROUND INSTALLATIONS.

A range of lighting boxes for collieries has been standardised by W. T. Henley's Telegraph Works Co., Ltd., one cast-iron base being used for all the boxes. For fiery mines a patented cover with flame-proof and watertight machined joint is provided. This is shown in Fig. 1, while in Fig. 2 is seen the watertight rubber gasket joint used for such situations as shipyards, factories, warehouses, etc. A universal cable gland is fitted in all cases. It consists of a heavy pressed brass cone and malleable iron armour grip. The brass cone is in direct contact with a machined recess in the box, and in conjunction with a rubber proofed tape packing forms a watertight gland capable of withstanding an hydraulic pressure of 70 lb. per square inch. For lead-covered cables, a lead bonding cone is provided; a feature is the galvanised malleable iron grip and pair of steel studs with spring washers and nuts, the combination serving—(i) To force the brass cone and tape packing into the machined recess to make a watertight joint; (ii) To clamp the armour wires; (iii) To bond electrically all metal parts to one another and to the earthing system by means of an earthing lug.

All cable entries are tapped for ¾ in. conduit, so that conduit may be used when desired. Where it is desired to provide for subsequent extensions, the boxes can be supplied ready drilled and fitted with a removable brass diaphragm clamped between the brass cone and the recess referred to above.

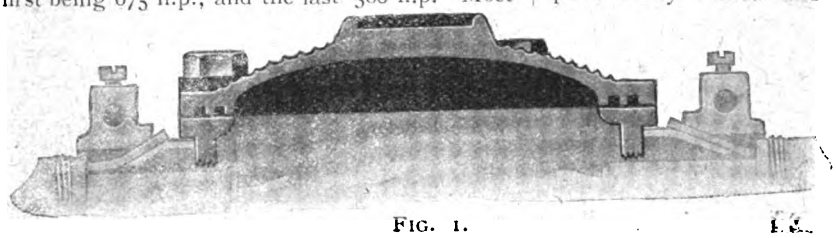


FIG. 1.

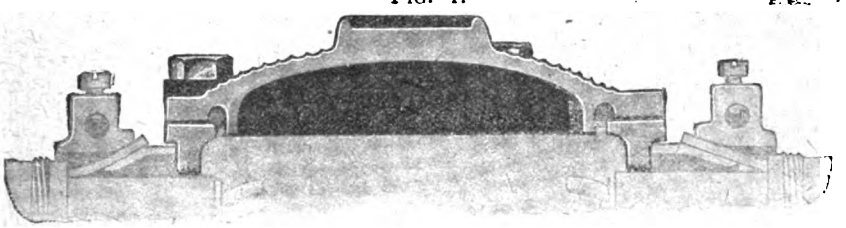


FIG. 2.

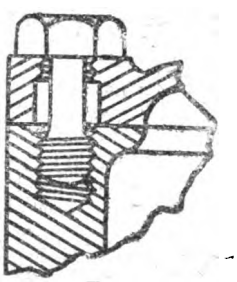


FIG. 3.

The lid is secured by means of four special screws (see Fig. 3) which cannot fall out accidentally, but may be removed when necessary. The interior fittings are mounted in a hard fireproof material, allowing ample clearance between poles and to earth.

The boxes are designed for unarmoured and single-wire armoured twin V.I.R. or Paper Insulated Cables up to 7/.036. Other boxes are made for cables up to 7/.064.

AUSTRALIA.

SUPPLY OF EQUIPMENT FOR THE MORWELL SCHEME.

A report in the *Industrial Australian and Mining Standard* on the tenders submitted in connection with the above comes at a most opportune time, as British manufacturers were beaten hollow by American on the score of price. We reproduce the report and trust that all our readers will go through it carefully.

"No tenders for Australian-made apparatus were submitted for any part of this work, and the Government, on the recommendation of the Commission, finally accepted the tender of the International G.E. Co., of U.S.A. for the whole apparatus at £379,000, which, it is stated, was

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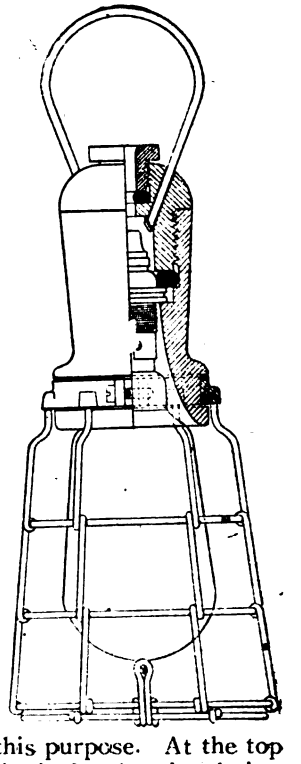
£300,000 less than any of the English tenders. The Premier issued the following statement:—

"The State Electricity Commission for some months past has been engaged in arranging for the execution of the various portions of the State electricity scheme. The whole of the site works, both at Morwell and in the metropolitan area, and all local erection and construction are being, or are to be, carried out by day labour, with materials and plant procurable, as far as possible, in the local markets. For all machinery, apparatus and electrical equipment tenders have been and are to be called on usual lines, inviting proposals from all the best manufacturers wherever situated. A number of such tenders have already been received and dealt with. Up to the present, the total value of the actual expenditure and commitments for future expenditure upon the several activities of the commission amount to upwards of £350,000, and this sum is distributed, roundly, as follows:—(a) Expenditure in Australia, £156,000; (b) expenditure in Great Britain, £106,000; (c) expenditure elsewhere than within the Empire, £88,000. Included in the expenditure upon goods of British manufacture are the turbo-generators for the Newport "B" power house, to the value of £100,000. This contract was secured, after competition, by Messrs. C. A. Parsons and Co., Heaton Works, Newcastle-on-Tyne, England. The commitments for expenditure upon plant outside of the British Empire comprise chiefly very specialised mechanical coal-winning and transportation appliances not procurable elsewhere than in the United States. Tenders have recently closed for that portion of the electrical installation comprised under the general heading of "transformers and switch gear." This includes the whole of the apparatus which transforms the electric energy from the voltage of generation at Morwell up to the voltage of transmission, also the switch gear and the electrical mechansim for operating the apparatus and all the control gear. It also includes the step-down transformers, synchronous condensers and switch gear of the Newport terminal station, as well as apparatus for a number of metropolitan sub-stations. No tenders for Australian-made apparatus were received for any part of this work. Only three formal tenders were received, that is to say, only three tenderers were able to submit tenders for the whole of the apparatus required. The commission, however, exhaustively investigated each item in every partial or informa' tender for the purpose of ascertaining whether, by selection, a break-up of the tenders could be effected in the interests of the scheme. The result of this analysis only made more clear the fact that the lowest tender, that from the Australian G.E. Co. (which tendered on behalf of the International G.E. Co., of U.S.A.), was by far the most economical. No British tender was received for the apparatus as a whole, but a selection of the lowest proposal of each British tenderer for each separate item indicated that the lowest possible price for the apparatus required amounted, on these lines, to £680,000. It is improbable that the British tenderers would agree to the lowest items being thus picked out of each of their tenders and those items only accepted. But even if that were possible the tender of the International G.E. Co. for the whole apparatus was £379,000, or £300,000 less than the lowest possible combination of English tenders. The term of delivery offered by this company is also more satisfactory than that offered by any other tenderer, and the State Eectricity Commission therefore recommended to the Government that the tender of the International G.E. Co be accepted.

"In considering the question of tenders from America, the preferential tariff in favour of British goods has had to be considered, as well as the rate of exchange. Even with these factors fully taken into account, the figures indicate a saving of at least £200,000 between a selection of all items from the lowest British tenders and the lowest individual American tender. In view of the obligation on the Commission to remove the disabilities which manufacturers and others in Victoria suffer by reason of the high cost of power, and to supply electric energy at the lowest possible rate, and in view of the fact that it is the actual capital cost of the scheme which will control the future price of electric energy, it has been decided to accept the tender of the International G.E. Co. for this portion of the work. The company whose tender has been accepted has a world-wide reputation for the excellence of its manufactures.

"The Electricity Commissioners have accepted the tender of the American Aluminium Company at £91,416 for the supply of conductors for the main transmission line from Morwell to Newport. The line will comprise six separate wires, making the total length of the conductors about 700 miles. The alternative materials open for consideration were copper and aluminium coated steel. The tenders received showed a heavy advantage in favour of steel, which has the further advantage of greater strength than copper, thus permitting of the employment of longer spans and, therefore, of fewer steel towers, insulators, and appurtenances. It is estimated that by the employment of steel-aluminium instead of copper conductors a total saving upon the whole outlay on the transmission line of about £100,000 will be effected. The landed cost of the steel-aluminium conductors in Melbourne, duty paid, will be more than £30,000 less than the lowest tender received for copper. The successful tenderer has entered into a guarantee that the whole equipment will be manufactured in and shipped from Canada. The conductors for the lower voltage and secondary distributory systems will necessarily be of copper, and for all such manufactures there will be an opportunity for the use both of Australian copper and Australian fabrication."

NEW SIMPLEX HAND LAMP.



A new pattern hand lamp (see sectional drawing herewith) is now being manufactured by Simplex Conduits, Ltd. (Garrison Lane, Birmingham) to replace List Nos. 804, 805 and 815, as shown in Simplex Conduits Fittings Catalogue, and also in the Industrial Lighting Fittings List. It complies with Home Office Regulations, and is suitable for use with any lamp up to a 60 watt vacuum type; its various other features may perhaps be best explained by short remarks on the various component parts of the handle, and gradually working downwards towards the wire lamp guard base.

The fixing of the leather loop handle is well secured by means of small brass eyelets in place of the nails or screws which are sometimes used for this purpose. At the top of the hardwood ebonized handle is fitted an insulating bush and primary cord-grip for flex; the secondary cord-grip and the lampholder being set and well fixed by means of a rubber packing ring, as will be seen from the illustration. The construction also includes a shield which prevents accidental contact with the metal portions of the lampholder and lamp-cap. The strong galvanized lamp-guard, fitted with a hinged door at its base, for the easy replacement of the lamp, is made secure, as may be noted, by a substantial brass clamping ring about the lower portion of the handle.

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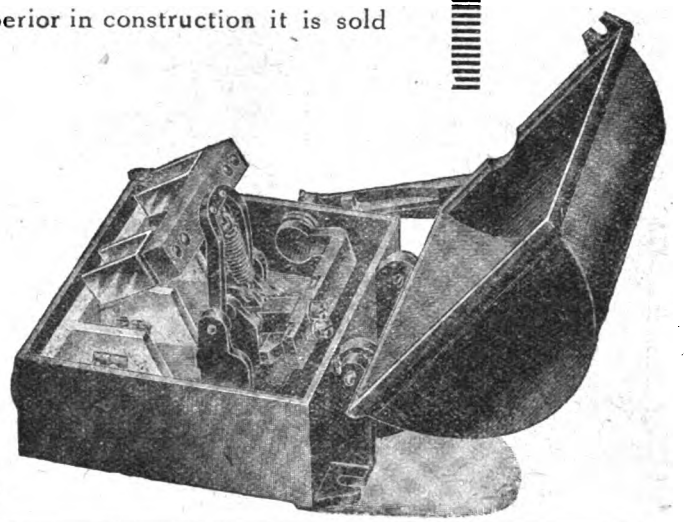
These switches embody a new patented principle by which both the closing and opening of the switch is done by an extremely easy working and positive action. Possibilities of tampering with the switch are overcome absolutely, and the switch is fool-proof. Though highly superior in construction it is sold at a competitive price.

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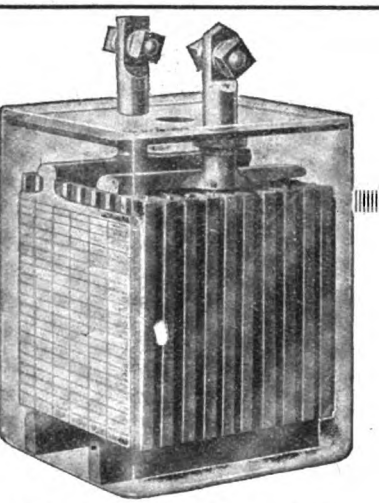
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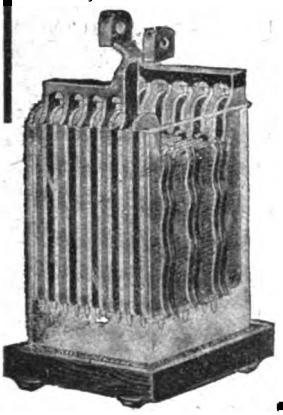
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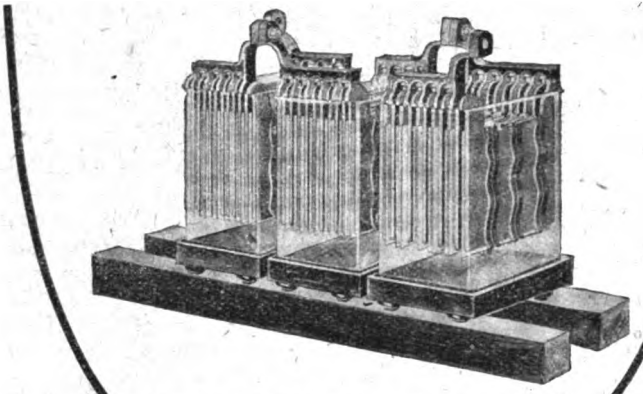
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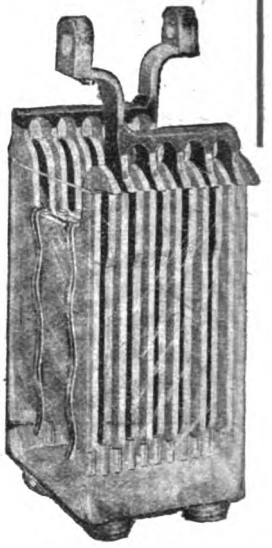
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

The Irony of It.

Liverpool has been patting itself on the back this week over the setting in motion of what is claimed to be the largest turbo-alternator in the world at the corporation power station, Lister Drive. The set has an output of 12,500 kw., and is capable of developing up to 15.625 kw., or 20,830 h.p. At the average price per unit received during 1920 it is estimated that when under full-load conditions the new plant will produce a revenue of £125 10s. per hour. This is the first of two machines of equal capacity to be installed at Lister Drive station. The second is now in course of construction. Together they will yield approximately 33,000 e.h.p. and occupy the same space as four machines of early construction which yielded approximately 10,700 h.p. Despite this recent addition to its generating plant, there is a main thoroughfare in a line with Lister Drive itself which has no service mains laid, and residents within sight of the power station are denied a supply except on payment of special cable costs, while Lister Drive itself is lighted by gas!!

Corporations and Co-operation.

A slight difference in the orthography but a vast difference in the interpretation. The need for greater co-operation between municipalities and private enterprise in the matter of electricity supply was Mr. Richardson's theme in his presidential address to the Incorporated Municipal Electrical Association. He said that just over a year ago hope had been high that great strides would be made in the direction of securing a cheap and abundant supply of electricity for the country, and that the Electricity Commissioners would banish all difficulties in the way of such a desirable end. Immediately upon the results of any constructive organisation becoming apparent, however, the various power-supply authorities felt that it would have to be a case of self-immolation for the benefit of the multitude. This resulted in a sudden preference for a conservative maintenance of the *status quo* rather than joining whole-heartedly in a collective effort which could not fail to be of great benefit to the community at large.

Another check, said Mr. Richardson, had been the quite unnecessary lack of mutual co-operation between municipally-controlled undertakings and those built up by private enterprise. Although the opinion that municipal concerns could not work so cheaply as those run by companies was to a certain extent true, the companies should give full credit to many municipal electricity authorities who had achieved notable successes in development, economy, and reliability. Regular readers of these notes will doubtless remember that in the early stages of the projected cheap electricity scheme, with its super-power stations, I remarked on the need for sinking individual vested interests, the suppression of parochial obstacles, and the urgent need for giving the scheme a fair start and not burdening it with the enormous financial burdens and economic errors of some of our short-sighted municipalities. The aftermath of my prophecy is now evident, and is voiced by Mr. Richardson.

Fortunately there is a glimmer of hope, and it would appear that some of our Bumbles are beginning to see reason and appreciate the need for broader and more enlightened views on the general question. As an example, the Birmingham Corporation and the Shropshire, Worcestershire, and Staffordshire Electric Power Company have arranged to submit to the Electricity Commissioners a joint scheme for the development of electricity supply in the South-West Midland district, comprising certain parts of Shropshire, Staffordshire, Warwickshire, and Worcestershire. This company and the corporation together supply 98 per cent. of the electricity generated in the district, and they propose to form a joint advisory committee to co-ordinate and enlarge the existing undertakings. By mutual agreement the company will be responsible for the development of the remainder of its area under its Act, with certain restrictions, and the corporation will be responsible for Birmingham and the portion of the electricity district situated in Warwickshire.

The advisory committee is to consist of two representatives of the company and two of the corporation, and will advise on the operating time-table of the undertakings, the best load factor obtainable, the conservation of fuel, the standardisation of systems, and other matters. This scheme forms a most remarkable example of a working arrangement between a corporation and a company, and it is likely to be of the utmost value to the economical and efficient progress of electricity supply over the area for which the two are assuming joint responsibility. It is an example which I heartily commend to the notice of other corporations and neighbouring supply companies, at present kept leagues apart by petty jealousies and imagined interference with each other's vested interests, what time the consumer foots the bill and awaits tardy and overdue permission to connect up more current-consuming devices.

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Our Telephones and Others.

There is a fund of humour in the present telephone *ramp*—as our Post Office friends term it. Quite recently the Engineering Section of the Post Office foregathered at their annual dinner, when many notabilities in the telephone and telegraph world were present, and there was quite a lot of mutual back-scratching. The gist of the defensive speeches was, "We're doing our best in a mighty difficult undertaking, and if the public don't understand we cannot help it." No doubt they *are* doing their best at headquarters, and the faults of their service do not lie with the very able departmental heads of the Post Office telephone service. The trouble is deeper seated, and Lieut.-Colonel O'Meara was very near the mark in his recent criticism of the organisation, referred to in my last week's notes.

The gentlemen who conduct affairs at the G.P.O. do not realise the absurdity of some of the red-tape methods which still prevail among the lower orders of their vast organisation. The oft-reported sending of half a dozen men to do one man's job is no exaggeration, and indicates woeful overlapping of duties or lack of detailed control. A case was reported to me in the provinces only yesterday, where four different officials called successively at a subscriber's premises to investigate the same "out of order" report, and each in turn left without doing anything. The fault was subsequently and mysteriously cleared. I have myself seen a gang of five to six men spend a full day, with hand-cart and considerable equipment of tools and material, fixing two wires and a chimney bracket to one brick chimney on the house I live in. I have also seen a man come and recharge the Leclanche cells associated with a certain Post Office 'phone, when the fault was in the handset cord. I could cite numerous other instances, but let these suffice. Many littles make a mickle. Immediately following that engineering dinner came an announcement that the deficit on the French telephone service this year will amount to over eight millions. M. Louis Deschamps, in charge of the Post Office during the last Administration, says that the only way to place the French telephone service on a paying basis is to spend sixty millions, take it out of the hands of the Post Office, and hand it over to young and competent engineers. If the French Chamber does not favour this proposal the only alternative is to hand the telephones back to private enterprise, as it will have been proved that the State is unable to work them.

So it would seem that we have an Entente Cordiale even in the matter of our respective telephone troubles. What a pity the news did not come through in time for that dinner; it would have added further zest to the speeches. This week I spoke to a prominent Dutch engineer on the subject of telephones in Holland. He said that his country had quite a decent service, but, like everyone else, they grumbled occasionally at its drawbacks. Apropos of the dinner speeches, I see that the worthy president of the institution does not find the telegraph service all that could be desired in the matter of speed, whilst he won't have a telephone at his house on any account. Rather a nasty backhander from an honoured guest.

ELEKTRON.

EARTHING OF FACTORY AND WORKS INSTALLATIONS.

In the July issue of *Installation News* (Simplex Conduits, Ltd.), "Cadmus" writes as follows:—

As every "authorised person" in charge of electrical plant on premises or works which come within the scope of the Factory Acts knows, the Home Office "Electricity Regulations" require that, "when necessary to prevent danger, adequate precautions shall be taken . . . by earthing . . . to prevent any met ' other than the conductor from becoming electrically charged," and that in extenuation Mr. Gilbert Scott Ram, in the "Memorandum of Electricity Regulations," states: "In an installation where the wires are protected throughout by substantial metallic tubing, the earthing can be simplified by making the separate lengths of tubing electrically continuous, so that actual connection with earth at one or two points only may be sufficient."

In many installations it will be found that the attempt to comply with this regulation has been made in a slipshod manner, and that the earthing arrangements are worse than none, as they give rise to a false sense of security. It is a common practice to terminate the conduit carrying the wires to a motor several inches short of the motor, the earth connection being made by a piece of comparatively light cable bared at the ends, one of which is secured under a foundation bolt of the motor, and the other wrapped round the tube and "tacked" with a spot or two of soft solder. This does not make either a safe or a permanent job, and as efficient earthing is both a protection from fire and a safeguard for human life, too much attention cannot be paid to this matter, especially in view of the fact that a little extra expense in labour and material may save hundreds of pounds.

In an installation carried out in Simplex screwed conduit, additional conductors for earthing purposes are unnecessary, and the untidy pieces of "earthing wire" can be dispensed with, conditionally that the conduit is installed as intended by the designers of the system.

In the following paragraphs, some of the methods which can be adopted to earth the various parts which make up an installation are described, the aim being to give an account of several of the more efficient arrangements which may be carried out with a minimum use of special conductors.

In the first place, when screwing the various lengths of conduit together, as little as possible of the screwed portion should be left projecting beyond the coupling, and where running couplings are necessary, these should be secured by lock nuts at both ends, a process which not only serves as a mechanical security, but also assists in making the conduit electrically continuous. Should the main switchboard be of the "Ironclad" type, very little difficulty will be experienced in making an efficient earth connection, but if the board is of the open type, the proposition is not so straightforward. In the case where the conduit terminates at the top of the board, the various runs may be secured and bonded together for earthing in the following manner. A flat bar is run along the top of the switchboard about eight or nine inches from the back of the panels; Simplex "outlet nipples" are screwed on to the ends, after which the nipples are screwed on to the bar in the usual manner. The end of the tube should be passed through a clearance hole in the bar and fitted with an insulating or lead bush. Should the various runs of conduit terminate at the bottom of the board, the same method can be adopted except that the tube should first be passed through the clearance hole in the bar, the outlet nipple then screwed on to the tube, and the nipple in its turn being screwed to the bar.

Each run of conduit must be electrically continuous and where it is necessary to enter a switch or motor starter, this can be done without breaking the electrical continuity by means of a suitable length of flexible metallic tubing at one end of which has been soldered a screwed reducer to

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fit the conduit, and at the other an outlet nipple as shown in Figs. 1 and 2.

Many motor starters are so constructed, that it is difficult to make the conduit electrically continuous without the use of "earth wires," as the deep cover over the front of the starter is mounted directly on the slate base, the cover or casing being simply provided with slots to clear the wires or cables which are attached to terminals mounted on this slate. The desired conditions, however, can be obtained by the means described below. A piece of sheet metal ⅛ in. to 3/16 in. thick is cut to a size long enough to cover the slots in the front casing or cover of the starter and about twice as wide as the depth of the front cover. This piece of metal is "offset" or "joggled" about ⅜ in. or ½ in. along the middle, and one side is drilled so that the plate can be bolted or screwed to the back part of the starter, the front part being drilled to take the outlet nipple end of the flexible terminating pieces referred to above. This arrangement is shown in detail in Figs. 3 and 4, from which it will be seen that this method provides complete protection for the wires together with electrical continuity for the tubing. The front casing can also be removed at any time for examination or repairs without disturbing the wiring, and the casing of the starter is thus earthed in a neat and satisfactory manner.

The earthing of fixed motors is not very difficult where the machines are provided with a terminal box, which forms part of, or is securely attached to, the motor. The conduit is simply taken right up to the motor and screwed into the terminal box, which should have a tapped hole for its reception.

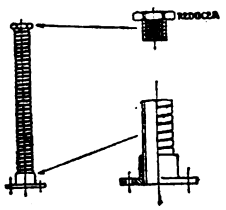


FIG. 1.

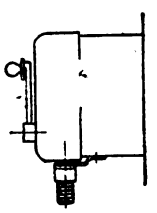


FIG. 2.

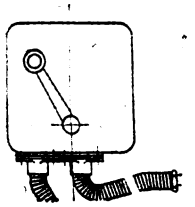


FIG. 3.

FIG. 4.

A more satisfactory method is to make up the final eighteen inches or two feet of the conduit run with one of the flexible terminating pieces previously referred to, the outlet nipple end being screwed on to the terminal box, and the reducer end on to the conduit. This method allows slide-rail adjustments, or for the motor to be dismantled at any time with a minimum of disturbance to the wiring, since to disconnect the motor all that is required is to unscrew the flexible tubing from the terminal box, disjoin the wires, and draw the whole away from the motor, which is then free for removal or overhaul.

Where the motor is not provided with a terminal box, this very convenient adjunct can be made from Simplex standard boxes and porcelain interior fittings. For motors taking up to 30 amperes, two No. 5410 interiors in a No 1194 adaptable box should be used.

The box should be mounted in a suitable position on the motor, the leads to the terminals from the windings of the motor being taken through a bushed hole in the motor frame or end plate, according to the position of the box. With two No. 5410 interiors, the connections of the terminals can be arranged to suit either a shunt, compound or series wound D.C. machine, or a stator of a wound rotor induction motor. Where the motor is of the squirrel cage type and is started by means of a "star-delta" switch, three No. 5410 interiors in a No. 1199 adaptable box should be used which will give the necessary six terminals.

Should the motor take a heavier current than can be carried by the above interiors, Simplex large junction boxes of a suitable size should be used with the requisite number of interiors which, being obtainable in single, double or triple pole, can be arranged to suit any type of motor.

It should be particularly noted that the method of attaching conduit to switch casings, distribution boards, adaptable boxes, etc., by means of passing the conduit through a clearance hole in the casing or box, and securing by a lock nut on each side, does not form an efficient earth connection as the writer has found by experience. Outlet nipples attached by well-fitting screws should be used, or the casing drilled and tapped and the conduit screwed into the tapped hole.

After making the conduit of an installation electrically continuous throughout, the next point to consider is the actual earth connection. This is best effected by means of a copper band "wiped" on to the water main on the supply side of the meter and main valve. To do this, the main must of course be dry, but where this is impracticable, a good earth connection may be made by means of a Simplex No. 6188 or 6189 earthing grip.

To make a permanent job, the pipe or main should first be well cleaned, and then the earthing grip placed on the pipe and screwed up until the teeth or serrations are almost touching the pipe The spaces between the teeth and between the grip and the pipe should then be filled up with pasty amalgam, and the grip screwed up tight. This makes a permanent low resistance earth connection, the amalgam preventing oxidation of either the grip or the pipe.

The amalgam may be prepared by melting common plumbers' solder in a ladle and then adding an equal weight of mercury, the whole being well stirred and afterwards allowed to clear.

Should any point be not quite clear, or should any further information on the subject be required, the writer will be pleased to answer as far as possible any queries sent to the Editor of "Installation News" which may arise from this article.

ELEMENTARY DETERMINANTS

WITH SPECIAL REFERENCE TO KIRCHHOFF'S LAWS.

BY H. P. FEW.
Silver Medallist in Telegraphy, etc.

ELEVENTH ARTICLE.

NOTE.—The aim of these articles is to bring out prominently the advantages of employing determinants, in conjunction with Kirchhoff's laws, for finding current values in complicated networks of conductors. The previous articles appeared in our issues of June 25, August 6 and 27, September 17, October 22, December 3, 1920 February 25, March 25, May 6 and June 24, 1921, and gave an account, *inter alia* of Kirchhoff's laws and corollaries, Maxwell's cyclic equations, general methods of evaluating determinants, application of determinants to finding current values in simple networks, including the Wheatstone bridge, the Thomson double bridge, the bridge duplex system of telegraphy, the "leak" system of telegraphy, etc.. This article deals with a power and lighting network.

Analytical methods are sometimes employed in determining the current values in power and lighting networks, the object being to ascertain whether the current densities exceed prescribed maximum limits.

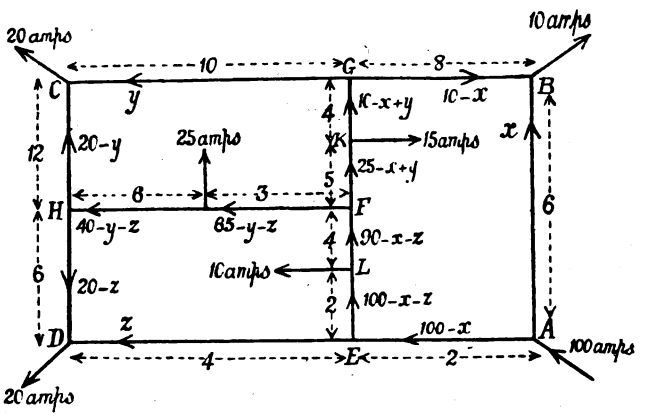


FIG. 26.

Fig. 26 represents a part of a power network. A current of 100 amperes is led in at *A* and tapped off at

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various points as shown. The figures represent the resistances of the conductors alongside of which they are placed.

As there are three meshes, choose three of the leading off points—say, *B*, *C* and *D*—and assume that currents x, y and z respectively flow towards the leading off points, then the currents in all the other conductors may be written down in terms of x, y and z by applying Kirchhoff's first law to each junction. Thus, if a current x flow along the conductor *A B*, the current flowing along the conductor *A E* will be $(100-x)$ amperes; that flowing along the conductor *E L* will be $(100-x-z)$ amperes; and so on.

Applying Kirchhoff's second law to the mesh *A B G F E*, we have

$$6x-8(10-x)-4(10-x+y)-5(25-x+y)-4(90-x-z) -2(100-x-z)-2(100-x)=0$$

$$i.e.,\ 31x-9y+6z=1005 \quad \ldots\ldots\ldots\ldots (1)$$

Taking the mesh *F G C H*, we have—

$$5(25-x+y)+4(10-x+y)+10y-12(20-y)-6(40-y-z) -3(65-y-z)=0$$

$$i.e.,\ 9x-40y-9z=-510 \quad \ldots\ldots\ldots\ldots (2)$$

Similarly with mesh *D E F H*—

$$4z-6(20-z)-6(40-y-z)-3(65-y-z)-4(90-x-z) -2(100-x-z)=0$$

$$i.e.,\ 6x+9y+25z=1115 \quad \ldots\ldots\ldots\ldots (3)$$

Solving equations (1), (2) and (3) for x—

$$x=\frac{\begin{vmatrix}1005 & -9 & 6\\ -510 & -40 & -9\\ 1115 & 9 & 25\end{vmatrix}}{\begin{vmatrix}31 & -9 & 6\\ 9 & -40 & -9\\ 6 & 9 & 25\end{vmatrix}}$$

The determinant for y is—

$$y=\frac{\begin{vmatrix}31 & 1005 & 6\\ 9 & -510 & -9\\ 6 & 1115 & 25\end{vmatrix}}{\triangle}$$

where $\triangle$ is the same denominator as for x. Expanding the numerator for y—

$$y=\frac{31\{(-510\times25)-(1115\times-9)\}-9(1005\times25)-(1115\times6)\}+6\{(1005\times-9)-(510\times6)\}}{\triangle}$$

$$=\frac{-285990}{-24052}=11.88 \text{ amperes.}$$

The determinant for z is—

$$z=\frac{\begin{vmatrix}31 & -9 & 1005\\ 9 & -40 & -510\\ 6 & 9 & 1115\end{vmatrix}}{\triangle}$$

Expanding this, we have—

$$z=\frac{31\{(1115\times-40)-(-510\times9)\}-9\{(1115\times9)-(1005\times9)\}+6\{(510\times9)\ (1005\times-40)\}}{\triangle}$$

$$=\frac{-799850}{-24052}=33.25 \text{ amperes.}$$

It will be found that these values satisfy equations (1), (2) and (3) above.

Knowing the values of x, y and z, the value of the current in any part of the network may be obtained, *e.g.*,

current in $F\,K=25-x+y$
$=25-29.43+11.88=7.45$ amperes

current in $K\,G=10-x+y$
$=10-29.43+11.88=-7.55$ amperes

the minus sign indicating that the current flows in the opposite direction to that shown. In this way, the current in any of the conductors can be calculated.

THE CHARACTERISTICS OF THE MULTI-SPEED INDUCTION MOTOR.*

By F. CREEDY.

(*Concluded from page* 409.)

We have now dealt fairly fully with the characteristics of a multi-speed induction motor with the exception of questions of efficiency and power factor.

Comparing the performance curves for the 70 h.p. motor previously referred to, it is seen that the efficiency of the machine with high resistance and with low resistance rotors on the same speed is not very different, while the power factor of the machine with high resistance rotor is a good deal less than that of the machine when fitted with low resistance rotor. This is due to a method which can be employed in the induction motor to enable a high resistance rotor to be employed without loss of over-all efficiency. The torque of the motor is, of course, proportional to the product of ampere conductors by flux density. If, therefore, we compare two motors having, say, flux densities in the ratio of 1.5 to 1, then, in order to give the same torque, they will require a number of rotor ampere conductors in the ratio of 1 to 1.5, the machine having the stronger flux density requiring only two-thirds of the current in the rotor bars required by that having the smaller flux density; two-thirds of the rotor current means, of course, four-ninths, or less than half of the rotor I^2R loss, and, consequently, if we wish the resistance loss to be the same in both cases, the machine with a stronger flux density may have 2¼ times the rotor resistance of that with the weaker flux density. This method was adapted in the motor illustrated in the above figures, which, by means of tappings on the transformer, was adapted to operate either with a strong or a weak flux; the strong flux used with the high resistance rotor involves, of course, low power factor, and this is the explanation of the nature of the curves shown. By using stalloy steel punchings the iron loss was reduced to such a small proportion of the whole that the increased iron loss due to the stronger flux produced only a negligible effect on the efficiency. Thus by this process the squirrel cage motor can be adapted to give any desired starting torque without loss of efficiency wherever we are prepared to sacrifice power factor to obtain this result.

A study of the circle diagram for such a motor shows that, ignoring small differences due to variations in efficiency, the power factor depends only on horse-power load, and not on the speed. At low speed, of course, it is impossible to obtain a high power factor, but this is due to the small

* Abstract of Paper read before the London Branch of the Association of Mining Electrical Engineers, and printed in full in *The Mining Electrical Engineer* for May.



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horse-power output of the machines. Further, the diagram shows clearly the very great economy in starting current which we obtain in the pole-changing motor, e.g., on 16 poles the motor absorbs but one-third of the starting current taken with the six-pole connection. Since the motor gives the same torque at all speeds, the machine can nevertheless yields a powerful starting torque at the lowest speed. These results may be further confirmed from test curves which show also the power factors of the machines. On the higher speeds the power factor is quite equal to that of the single speed motors of the same rating, but it inevitably falls off considerably on the lower speeds, the range of power factor from top to bottom speed being something of the order of 20 per cent. in a motor having a speed range of 2 to 1 or 3 to 1. This drop in power factor, however, as just mentioned, is not greater than that which is usually found between full load and one-third load in many single-speed induction motors.

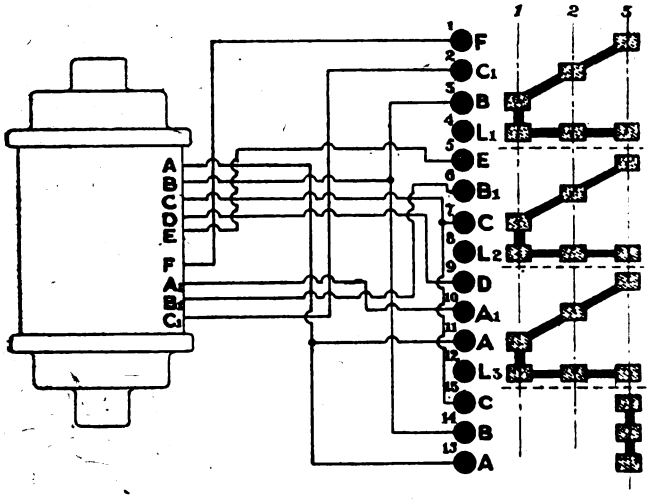


FIG. 1.

We have now described fairly fully the necessary characteristics of a multi-speed induction motor, and have illustrated them from test results obtained. These qualities may briefly be summed up as follows :—

(1) While continuous speed variation is not possible, any number of distinct speeds can be obtained up to about six. On all these speeds which correspond to different pole numbers the efficiency will be approximately the same, declining no more than 10 per cent. between top speed and bottom speed in motors having a speed range of 3 to 1. In large motors these variations will be very much less, say not more than 5 per cent. Broadly speaking, the reduction is caused by the fact that the losses remain practically the same on all speeds, while the h.p. output goes down with the reduction of speed.

(2) The power factor will decline not more than 20 per cent. between the highest and lowest speeds in a small motor having the same speed range. Broadly speaking again, this is due to the fact that the magnetising volt amperes remain the same at all speeds, while the true power input is reduced in proportion to the speed by the reduction of the h.p. output. Again, in large motors the variation may not be more than 10 per cent.

(3) The rush of current which occurs on changing speed may be minimised by having a sufficient number of speeds and reduced to, say, twice full load current momentarily if the steps between adjacent speeds are sufficiently small.

(4) The starting torque of a machine with short-circuited secondary, having a speed range between 2 to 1 and 3 to 1, will be very much more satisfactory than in a single-speed motor, a figure of full load torque with twice full load current being readily attainable in a motor having a 3 to 1 speed range.

(5) It is readily possible to arrange for the multi-speed motors to start with resistance control on one of their speeds, for instance, the top speed, switching over to the remaining speeds by means of a contactor panel in the manner already described, so as to entirely avoid any current rush on change in speed.

(6) Methods exist whereby motors can be built having resistance control on all speeds. Such motors can be used with phase advancers as unity power factor machines. It will readily be conceded that machines having these characteristics go a long way to solve the problem of the variable speed A.C. motor.

It will now be of interest to describe some of the typical circuits used with the multi-speed electric motors. In the smaller sizes, motors without resistance control are used wherever possible; and in Figs. 1 and 2 are shown diagrams of connections typical of three-phase, three-speed and four-speed motors. It will be seen that the three-speed motor requires a drum controller having 15 fingers, while the four-speed motor requires 21 fingers.

For two-phase motors a somewhat larger drum controller is required; this is spaced for 28 fingers, of which 24 are fitted for a two-phase, four-wire system. In the larger sizes the controller is frequently made up with two drums geared together.

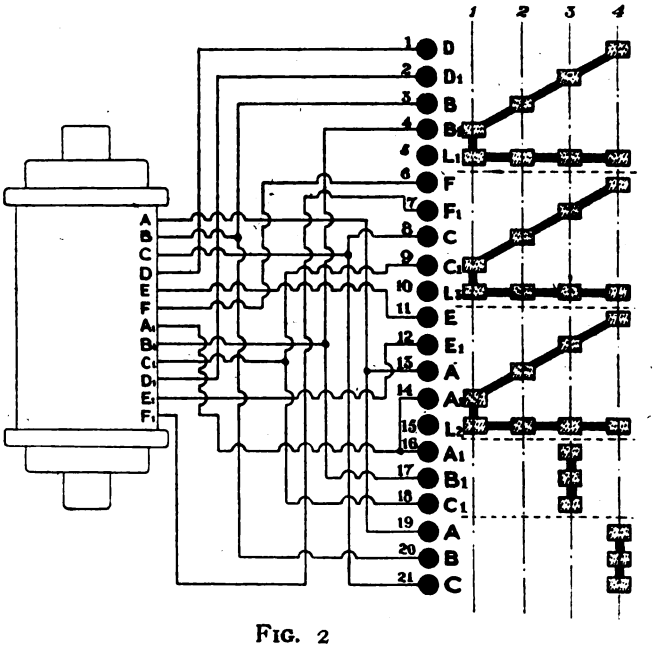


FIG. 2

We now come to the case where speed control is required by the use of resistance, or where exceptionally heavy torques have to be dealt with, and consequently resistance starting is essential. In Fig. 3 is shown a two-speed motor capable of giving resistance control on one of the speeds. The same diagram is available for a motor giving four and six, six and eight, eight and twelve poles, etc., the resistance control, however, being on the six-pole or twelve-pole speed. It will be seen that the switching is of extreme simplicity, there being a three-bladed double throw switch instead of a drum controller, the motor having only ten terminals, six for the primary circuits and four for the secondary. The secondary resistance is of the standard two- three-phase type.

Considering this as arranged for six and eight poles, with the switch in the position corresponding to six poles, the resistance circuit is gradually closed and the machine starts with a powerful torque, just like a standard slip-ring induc-

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tion motor, and when the resistance has been cut out, reaching top speed, say 1,000 r.p.m., at 50 cycles. If it is required to run at a reduced speed of 750 r.p.m., sufficient resistance is inserted to bring the speed down to 750 r.p.m. at the load on which the machine is running. The switch is then changed from the position corresponding to the six poles to that corresponding to the eight poles, when the apparatus continues to run at 750 r.p.m., the resistance being automatically cut out without any further changes of connections. When arranged for a four and six-pole, of course the resistance control is only on the lower of the two speeds. Under these circumstances the machine will start with a powerful torque taking reduced starting current, as compared with the standard single-speed machine. For instance, to obtain twice full load torque with a standard machine requires twice full load starting current, while with a two-speed machine of the type we are now considering, twice

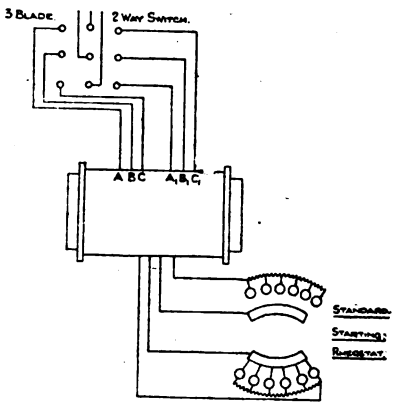


FIG. 3.

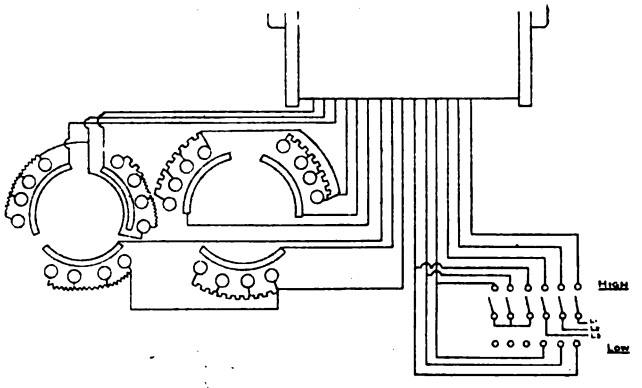


FIG. 4.

full load torque can be obtained with 1½ times the full load current. Having reached the six-pole speed, viz., 1,000 r.p.m., it is necessary to switch over in one step to the higher speed of 1,500 r.p.m. without the use of resistance, which in the case of large machines may not be permissible. To overcome this difficulty a somewhat more elaborate diagram has been prepared: Fig. 4 shows this, in which a six-bladed, two-way switch is required and two three-phase rheostats, there being altogether 15 terminals on the motor. The rheostats are usually connected by a link, so that they may both be operated by a single handle.

By the use of these circuits a motor having resistance control, and which is capable of changing over from a four-pole to a six-pole speed without shock in the manner just described, may be constructed.

The author is indebted to one of his licensees, the Electric Construction Co., Ltd., for help in preparing his paper.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 121.

Can any reader give me full details of the use and operation of the Tesla coil?—J.E.H.

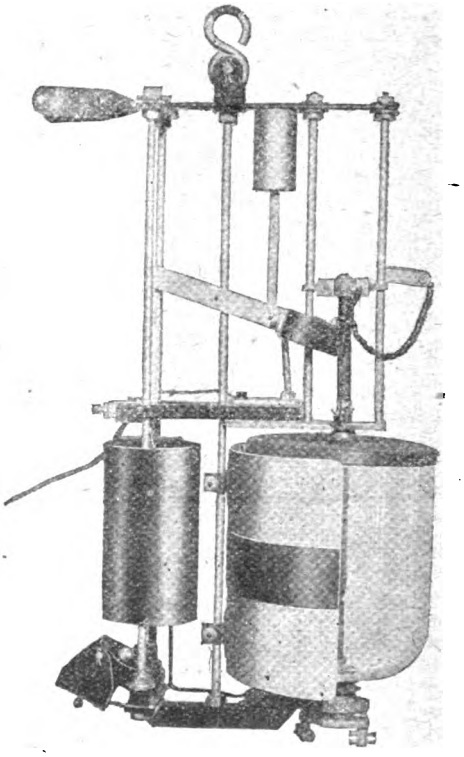
QUESTION No. 122.

Please can any reader give me full details of checking the ratios of various transformer connections, preferably "Scott," "Zig-zag," etc.?—J.E.H.

(*Replies to Questions Nos. 121 and 122 must be received not later than July 30, 1921.*)

A STUDIO ARC LAMP.

The semi-enclosed studio arc lamp, illustrated below, has been designed by the General Electric Co., Ltd., to use ordinary "Witton" carbons instead of the white flame carbons necessary with open type lamps in photographic



and kinema studios. Superior results are also claimed. It will be noticed that the mechanism chamber is level with the globe and behind the reflector, thereby reducing daylight shadow to a minimum. Incidentally the design brings

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the heavy parts low down, so that the lamp may be fastened to a stand a good height from the floor without the contrivance becoming top-heavy. Further, the operating solenoid is so far from the globe that the long lever gives a large multiplication of the movements of the solenoid core and gives the long strike to the carbon essential in lamps burning long actenic arcs. The accessibility of the various parts is evident from the illustration, while, owing to the length of lever used to lift the clutch gear, the line taken up by the lifting links attached to the clutch is always practically on the centre line of the carbon, thus eliminating side friction on the carbon or holder. The top carbon can be removed or inserted without removing the bottom carbon. The globe cap is of spun steel and works on a ball socket, through the centre of which the upper carbon is guided. The bottom carbon holder is also on the ball-and-socket principle. Thus the arrangements permit of the carbons being brought and maintained in alignment.

The lamps run on either A.C. or D.C., and should be connected in parallel on 200 to 250 volt circuits. For average work 16-c.p. lamps are recommended. The lamps are also suitable for blue printing.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.

HIGH TENSION SWITCHBOARDS. By Henry E. Poole. 114 pp., 22 figs. (Pitman, 2s. 6d. net.)—This volume supplements the companion primer on H.-T. Switchgear by the same author. It places before the reader a brief outline of the intricate subject of H.-T. switching for central and sub-stations, as well as for factories and collieries obtaining their electrical supply from public mains; the requirements necessary to be fulfilled in all cases, together with information concerning the design and construction of up-to-date boards being given. Types of mining boards as well as furnace control and other special boards are referred to, and there is a chapter devoted to protective gear—this is not exhaustive, but the well-established systems come in for illustrative mention. It must be remembered that the treatment in a "primer" cannot well go into critical detail, but there can be no doubt but that a simple treatment of the subject of H.-T. Switchgear was badly wanted, and this volume will meet the requirements of many. For some it will be sufficient and for others will serve as an excellent introduction to a more extended study of the subject.

ELECTRICAL INSTALLATION WORK. By J. H. Havelock. 366 pp., about 130 figs. (Lockwood. 15s. net.)—This book has been written for those in the electrical trade who are familiar with the principles of magnetism and electricity and have an elementary knowledge of practical mathematics, and is particularly adapted to the requirements of students of installation wiring work. By the term "student" we mean anyone desirous of improving his knowledge of his work and of bettering his position. It falls, therefore, in the category of text books rather than in that of books of reference, though it is well worthy of a place on the bookshelf. The treatment of the subject is on broad lines, and consequently it is not surprising that in just one or two items it is a little weak, particularly on heating and cooking. On electric lamps, too, some fault could be found but not of a serious nature. It should here be stated that in no part is space devoted to a routine description of practical work, but throughout can be traced an effort to enlist intelligent interest in the theory and applicaion of electrical principles. Considerable tabular matter is given concerning cables and wires, fuses, specific resistances, etc., while the I.E.E. wiring rules, Lloyd's rules and tables of logarithms are reproduced. The different systems of wiring are also compared in tabular manner, and there are many half-tone and explanatory line diagrams, besides switch controls, bell, telephone, electric light and motor circuits, etc The book is divided into three sections. Section I. is devoted to electrical calculations and contains a collection of miscellaneous problems (with the correct answers). Section II. deals with the theory and practice of electrical installation work, from bells and telephones to dynamos and motors, meters, fuses, primary and secondary batteries being also dealt with. Section III. impresses the need of sketching and making simple diagrams of connections, after which several examples of diagrams of circuits in common use are given. The present work is really a second edition, enlarged and revised to date, except in one or two minor points previously noted, of Mr. Havelock's "Electric Wiremen's Work," and can substantiate the claim to being "a practical handbook."

RADIOGRAPHIC TECHNIQUE. By T. Thorne Baker. 196 pp., 63 figs. (Constable. 15s. net).—"Just as many people ignorant of pure photography think that the possession of a good camera or a fine lens will secure the production of excellent photographs, so the radiologist is often led to imagine that high-power installations and lavish equipment must lead to the best radiographic results." This extract from the preface indicates the object of the book—an exposition of the details of photographic technique, of which knowledge is so necessary in radiographic practice. Chapter I. deals with the scope of X-ray work, apparatus and fault location, then follow chapters going thoroughly into the various aspects of the photographic side, the letterpress being aided by reproductions of good and bad results. Finally, a résumé of the industrial applications of X-rays is given and appendices of useful information, including a description of the Coolidge tube, complete the work.

EDMUNDSON'S.

The difficulties under which small electricity undertakings have been compelled to operate owing to Government control during and since the war was forcibly brought out by the chairman of Edmundson's Electricity Corporation, Ltd., at the 24th Ordinary General Meeting, on the 30th ult. Although the business has nearly doubled since 1913, the company can not even make such a meagre return as before the war, as although most of the maximum rates have been granted, any further adjustments can only be made under the powers of the Statutory Undertakings (Temporary Increase of Charges) Act, 1918, which restricts profits to an amount sufficient to yield three-quarters of the average pre-war dividend. Although costs will probably fall, the company will get little or no benefit until the statutory restriction is removed. Provision is made for this in the Electricity (Supply) Bill now before Parliament, but owing to opposition on several clauses it is very problematical when the Government will proceed with it. The Cumulative Preference dividend is one year in arrear, and the Ordinary shareholders have received no dividend for 15 years.

Holidays.—The Works of the London Electric Firm, Croydon, will be closed for the annual holiday from the evening of Friday, July 29, until the morning of Monday, August 8, but a small staff will be kept in attendance to deal with urgent business.

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Various Items.

China.—The Ta Tung Electric Light Company, Shansi, organised by Sung Fa-hsiang has been granted a registration in the Chinese Ministry of Communications.

Another Snub for Science.—Having thrown electric bulbs in to the road and produced loud explosions in order, as he told the magistrates, to bring down the rain, Alfred Spence, an Eastbourne householder, was recently fined for "depositing glass on the highway."

Personal.—Mr. William C. Jeary, late of The General Electric Co., Ltd., Armorduct Manufacturing Co., Ltd., Magic Appliances, Ltd., and recently Manager for Great Britain for N. V. Telga, Amsterdam, is now Managing Director of The Jeary Electrical Co., Ltd., 8, Lambeth Hill, Queen Victoria Street, which Company has been formed for the purpose of taking over the business of the late Mr. G. Braulik. Mr. Jeary will be pleased to hear from all old friends at above address.

Finance.—The Directors of the Charing Cross West End and City E.S. Co., Ltd., have declared an interim dividend on the Ordinary shares of the West End Undertakings for the half year ended June 30, 1921, at the rate of 3s. per share.—— The Directors of the Marconi International Marine Communication Co., Ltd., report an excellent balance sheet for the year 1920, and recommend a dividend of 10 per cent. which with the interim dividend of 5 per cent. paid January 1, will make a total of 15 per cent, for the year.

Development of Power Alcohol.—As a consequence of the removal of the duties and restrictions on the importation and manufacture of power alcohol, we are informed by the Alcohol Fuel Corporation, Limited, of 7, Princes Street, Westminster, S.W.1, that they hope shortly to put into operation the preliminary arrangements they have made for the production and sale of Natalite Motor Spirit in the United Kingdom. In this connection, Mr. E. S. Shrapnell-Smith, Mr. Geo. W. Watson, Mr. H. G. A. Harding, and Mr. J. Stanley Arthur have been retained as technical advisers to the Corporation.

"The Mexican Review."—The July issue of this paper, which is published in Washington, D.C., U.S.A., is as usual full of interesting matter, and continues to write strongly in favour of the steady resumption of perfect harmony between Mexico and the United States, a project which is sure to have the support of all right thinking politicians. One article deals with the probable close association of the ancient Chinese and Aztec civilisations, and another describing the wonderful floating islands of Xochimilco makes one wish to spend a holiday in this particular district. Altogether a very readable number.

Keenness of Foreign Competition.—Engineering employers with whom I have discussed the future of British industry are of the opinion that the public do not realise how very keen foreign competition is. Continental and American firms are undercutting us in practically every direction, largely because their costs of production are much lower than ours. Foreign engineering products are selling in this country at prices at which our firms simply cannot look. Boiler tubes of German manufacture are, for instance, purchaseable here for half the money it costs us to turn them out. Our workers should look facts like that squarely in the face. (Daily Press.) —The question is will they? It appears as if in many cases the workers would rather starve than act on the principle that half a loaf is better than no bread.

Electro-Harmonic Society.—At the annual general meeting, which was held on the 20th inst., the members present recorded with regret the sad loss which the Society had incurred in the death of Mr. T. E. Gatehouse, and an appropriate resolution of appreciation of his services for over 35 years was carried in silence. Sir Wm. Noble, Mr. F. H. Nalder, Mr. Dunn, Mr. New and Mr. Moss were elected members of the committee, and the secretary announced that arrangements had been made for concerts to be held at the Cannon Street Hotel on the following dates: Oct. 14, Nov. 11, Dec. 16, 1921; Jan. 13, Feb. 10, March 10, 1922. The subject of the increase in the annual subscription was discussed at length, and ultimately it was resolved that it should be raised to one guinea, but that the entrance fee of 5s. should be dropped.

Trade Notes.

"iZ" Electric Lamp and Supplies Co., Ltd. (73, Newman Street, W.1), have issued a new folder dealing with the Electrolux Portable Cleaning Apparatus. Supplies will be gladly overprinted free of charge with names and addresses of Trade buyers.

Messrs. Chamberlain & Hookham, Ltd. (Solar Works, Birmingham), have been successful in securing contracts for a twelve months' supply of electricity meters to the Municipalities of Glasgow, Battersea, Belfast, Gloucester, Islington, Bath and Llandyther.

A new leaflet received from the **Midland Electric Manufacturing Co., Ltd.** (Barford Street, Birmingham), illustrates and prices the 500 volt "Baby Paragon" ironclad switch and combined switch and fuse, also the 10/15 amp. "Baby Kantark" ironclad cut-out. These devices, it will be remembered, are small, neat and most satisfactory for light, power and heat control.

No. 2 of K. and J. News (**Kenrick & Jefferson, Ltd.**, 22, St. Andrew Street, E.C.4) deals with K. & J. methods of improving the efficiency of office work, e.g., there is the telephone account pad, filing system, telegram record book, K. & J. Super Fountain Pen, with the "difficult to break" nib, as previously illustrated in our columns, and also many other important items.

Messrs. Wm. Geipel & Co. (72a, St. Thomas Street, London, S.E.1) have acquired the business of **Quead Electric Fires** (Stock, plant, patents and goodwill) as a going concern. They have made special provision for the manufacture and sale of these fires at their St. Thomas Street works, where they will produce the whole range of apparatus listed in the Quead Catalogue. All correspondence should now be addressed: Wm. Geipel and Co., Quead Department, 72a, St. Thomas Street, London, S.E.1.

Telegrams:—"Micamini, Wandsouth, London." Telephone: Putney 405.
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A POPULAR SCIENTIFIC WEEKLY JOURNAL
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A PRACTICAL TRADE JOURNAL
AUGUST 5, 1921.

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ELECTRIFICATION OF MELBOURNE RAILWAYS.

The electrification of the Melbourne suburban railways, besides providing an infinitely better service, is effecting a saving of nearly £200,000 a year.

The scheme comprises a power house, high tension feeder cables, 16 sub-stations, 145 miles of track with overhead wiring and rail bonding, the conversion of 702 carriages, replacement of a large portion of the existing signalling system and construction of workshops for inspection and maintenance of car equipment. The capacity of the Newport power house is equivalent to 100,000 h.p. Electric trains travel at 31 per cent. higher schedule speed than steam-hauled suburban trains. This is largely owing to the rapidity with which maximum speed is attained on leaving stations. The large condensing plant at Newport power house was manufactured by a local engineering firm. Australian-made copper wire to the value of £110,000 is being used in overhead equipment, and arrangements have been made with contractors to utilise only Australian copper for cables and other conductors. The 8,000 tons of structures to be erected along the tracks will be manufactured locally, and, as far as practicable, from Australian steel. Australian-made cement, when procurable, is being used for foundations of the structures, and the sub-stations will be built as far as practicable from Australian-made materials. Owing to the war and to post-war conditions, it has been impossible to obtain from abroad by the due dates the balance of electrical equipment required for the completion of the scheme. This equipment must necessarily be imported owing to inability to obtain it in Australia. The delay has, however, enabled numerous recent engineering improvements to be embodied in the scheme.

Concerning the financial advantages of the scheme, it is stated by the Railway Commissioners that to operate the present electric service Newport power house requires approximately 54,000 tons of coal per annum, costing £70,000. To provide with steam locomotives an equally frequent service, but at much lower speeds, would require 91,000 tons, costing £128,000 per annum. The annual saving compared with a slower, but equally frequent, steam service, is therefore £58,000. If the cost of coal for additional trains provided under electrification were deducted, there would still remain an annual saving of at least £46,000. A steam train requires three men to operate it, whereas an electric train needs only two. As a result, notwithstanding the more frequent service, the number of men now required to operate the trains on lines so far electrified are 54 fewer than were employed under steam conditions. At the same time the amount of rolling-stock used on these lines has been reduced by 50 locomotives and 25 cars. By these means savings in wages, interest on cost of released rolling-stock and in maintenance of same already amount to not less than £50,000 per annum. Since electric services commenced there has been a growth of revenue on all suburban lines, but the increase on electrified lines has been considerably in excess of the average. The difference is undoubtedly due to the better service provided under electric conditions. Records indicate that the value of this additional revenue, created by the electrification of only five lines, will not be less than £95,000 per annum. The apparent monetary benefits derived from electrification of five lines are :—

	Per Annum.
Saving in coal	£46,000
Saving in staff and rolling-stock	50,000
Increased revenue due to better service	95,000
Total	£191,000

An important further increase of revenue is forecasted as a result of elimination of smoke, which, when the scheme is complete, will permit of office buildings and shops being constructed on railway premises at Flinders Street and Princes Bridge. The rentals from such conveniently situated buildings will be considerable. The higher speed of electric trains and their flexibility at terminals enable a much greater volume of traffic to be handled with the same tracks and stations than is possible under steam service. In this way electrification has postponed the necessity for costly duplications and extensions. In 1912 it was estimated that, without electrification, additional suburban facilities costing £2,100,000 would be required before 1927. In view of subsequent increase in prices, there is little doubt that the work would actually cost more than £3,000,000. Interest on this sum has been saved for the period by which electrification enables the work to be deferred. If the period gained were ten years, as seems probable, the accumulated saving in interest alone would be approximately £1,500,000.

In regard to suburban goods service, it is pointed out that an electric locomotive uses power only when working, whereas a steam locomotive necessarily burns coal at all times when on the road. Suburban goods trains are often unavoidably delayed in sidings for long periods, during which much coal is burned and wages paid, but no work is done. To eliminate this waste and further economise in staff, it is intended to introduce electric locomotives for use on suburban goods work and also for shunting purposes. As the traffic on main country lines develops, it will become justifiable to electrify busy sections which are within reasonable distance of a cheap power supply. Investigations are already being made to determine which lines offer good prospects of financial success.

The capital cost of the present scheme, when completed, will be approximately £5,000,000, involving an annual interest bill of about £250,000. At present 44½ miles are electrified, leaving 98½ miles yet to be converted. There will also be new working expenses in operation of power house and sub-stations, maintenance of electrical equipment, and increased cost of maintaining tracks, due to denser traffic, higher speeds and greater weight of electric trains. For the lines now electrified these additional expenses amount to about £90,000 per annum. The ultimate increased working expenses when the scheme is completed cannot yet be accurately stated, but should not be more than £250,000 per annum. The total estimated additional interest and working expenses for the whole electrification scheme may therefore be set down at £500,000 per annum. Against this should be set the economies and additional revenue resulting from electrification. Only one-third of the suburban lines has yet been electrified, but the financial benefits recorded already amount to £191,000 per annum. To this must be added a considerable sum which, but for electrification, would have had to be paid annually for interest on the cost of the additional facilities for steam traction that would have been required. The lines still to be electrified, in some cases, traverse sparsely settled areas,

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and should produce, in the future, a greater relative increase in revenue than the lines now electrically operated. Further savings will also be possible when the suburban goods trains are operated by electric locomotives.

"There is every reason to believe," the Railway Commissioners state in a Report, "that the suburban electrification, while conferring on the public the great advantages already referred to, will offset, by savings in operation and enhanced revenue, all additional expenses involved in connection therewith, and will prove a marked financial success. The electrification scheme will be completed with the least avoidable delay, and no other city in the world of the same size will then have such an efficient rapid transit suburban service as the city of Melbourne."—(*Industrial Australian and Mining Standard.*)

CARRIER CURRENT TELEPHONY AND TELEGRAPHY.

A Paper read a short time ago before the American Inst.E.E. by E. H. Colpitts and O. B. Blackwell, of New York, briefly outlines first the history of the development of carrier multiplex telegraphy and telephony. The fundamental principles underlying particularly the newer developments of the art are then discussed. Consideration is likewise given to the propagation characteristics of open wire lines, including those containing intermediate lengths of cable. Commercial types of apparatus and actual installations are then described and a brief statement made as to further applications of the art.

The carrier method of multiplexing telephone and telegraph lines is technically one of the most interesting and important of the developments which have been perfected in the art of electrical communications during the past few years.

A number of separate telephone, telegraph or signalling messages are superimposed simultaneously on a single electrical circuit by employing a separate alternating current, usually called a "carrier current," for each of the separate messages. This carrier current is made to vary in accordance with the variations of current representing the message. The different carrier frequencies which are superimposed on a circuit must differ sufficiently in frequency so that they may be separated from each other at the terminals by the use of proper electrical circuits. Each carrier may be of either audible or ultra-audible frequency, but its frequency must be higher than the highest frequency represented in the message to which it corresponds. These currents are known as carriers, since, in a sense, they may be said to "carry" the telephone, telegraph or signalling currents by which they are controlled.

The carrier circuits, both telephone and telegraph, are so designed that, as circuits, they fit in completely with the more usual circuit facilities of the telephone system. They may be connected with each other and with ordinary circuits, and, in general, present much the same degree of practicability and flexibility of operation as do the more usual forms of circuits.

However, the cost of these systems, at least at present, is such as to make their use economical only over relatively "long toll circuits." For short distance toll service, and for local exchange service, the equivalent facilities can be provided more cheaply by the older methods.

The foundation of the carrier art was laid back in the 1890's, at which there had been contributed these cardinal features:

1. Electrical selection of tuning.
2. The use of continuously generated high frequency carrier currents.
3. Modulation of the carrier, as by a microphone transmitter.
4. Detection and indication of the high frequency currents by means responsive continuously and proportionally to the received current.

After tracing the history of development, the authors state that the most important developments, which have occurred since 1912 and are principally the work of the Research and Development Departments of the Bell System, may be stated as follows:

1. Development of the thermionic vacuum tube into a reliable and stable instrument for amplification, modulation and demodulation.
2. Development of the electrical filter and an improved technique of separating electrical currents of different frequencies.
3. Development of the technique of transmission over wires, particularly in connection with repeater operation and in methods of overcoming interference between circuits.
4. Development and operation of commercial carrier systems.

The success which has attended the development of the thermionic vacuum tube as an amplifying element in a telephone repeater and its application to radio telephony indicated that in this one device was embodied the solutions of many of the controlling difficulties that had previously stood in the way of the commercial development of carrier systems. In connection with a resonant circuit, the vacuum tube provides a compact and reliable source of continuous oscillations of readily adjustable frequency. As an amplifier of both low and high frequency currents, it removes the necessity for excessive line currents. As a modulator and demodulator, it provides an ideal means of impressing the voice waves on the carrier current, and of restoring them to their original form at the receiving end. These tubes have, moreover, been developed into devices which are very stable and reliable in operation, and may be maintained with only routine periodic supervision.

Another development which has been of vital importance in the success of carrier telephone systems is that of the "band filter" invented by G. A. Campbell. Without such electrical filters it would be impossible to utilise economically the relatively low frequency range employed in the present carrier telephone systems, or to separate various channels in this range from each other or from the ordinary telephone and telegraph channels. The simple tuned circuits of the prior art would either introduce prohibitive distortion, or, if made sufficiently non-selective to avoid distortion, would require placing the carrier channels widely apart in frequency. The Campbell filter, therefore, enabled the carrier channels to be squeezed closely together at comparatively low frequencies where the difficulties of transmission over lines is at a minimum.

Since the attenuation over wire circuit is much greater at carrier frequencies than at the ordinary telephone frequencies, the successful operation of carrier systems is particularly dependent on the use of repeaters at comparatively frequent intervals in the line. This has required the development of high-frequency repeaters involving the application at high frequencies of all the developments of the repeater art. As in the case of telephone repeaters at voice frequencies, the amount of amplification which can be given by each repeater depends entirely on line conditions, such as the degree of line balance which can be maintained at the repeater point and the degree to which mutual interference between line circuits can be prevented.

This prevention of interference between line circuits required the development of more elaborate methods of transposing and adjusting them. In order to overcome the large transmission losses and irregularities introduced in open-wire lines by unavoidable sections of cable, new types of loading for cable circuits were developed for these carrier frequencies and put into practical use.

In 1914, simple forms of carrier circuits, embodying the fundamentals of the present system, were successfully set up in the laboratory, and experiments carried out with them. In view of the favourable conditions which had resulted from the various developments noted, it was decided to begin active work toward commercial carrier systems. Field measuring apparatus was developed with which the charac-

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teristics of existing telephone lines were carefully studied in the carrier-frequency range. At the same time in the laboratory the physical possibilities and limitations of the various types of apparatus and circuits were being studied. Based on these fundamental data there was developed in the laboratory a complete multiplex telephone system providing two-way telephone conversations, and operating over an artificial line. This laboratory apparatus was then taken into the field and tried out on a line between South Bend, Ind., and Toledo, Ohio. The practical difficulties always encountered were overcome, and satisfactory operation secured. At the same time satisfactory results were obtained on a simple type of carrier telegraph system between Chicago and Toledo.

The entry of the U.S. into the war brought the work to a standstill for a time. However, the same cause created a demand for more telephone circuits between Washington and Pittsburg. It was decided to meet this demand by a trial installation of a carrier telephone system between Pittsburg and Baltimore, from which point cable circuits to Washington were available. In view of the urgency of the situation, the apparatus used in the earlier field experiments was adapted to equip the Pittsburg terminal, while new apparatus was built for the Baltimore terminal. This carrier system went into service and has since been operating satisfactorily.

PRINCIPLES OF OPERATION.

General.—The underlying principles of carrier systems will be described in their application to carrier telephony. Their application to the somewhat different conditions of carrier telegraphy will be treated separately in a later section.

Modulation.—The process by which the carrier current produced by the oscillator is so combined with the voice currents from the telephone transmitter that the variations of the latter are impressed upon the former, is known as "modulation," and the tube circuit in which this is accomplished is known as the "modulator."

The potentials of carrier and voice frequencies are applied in series in the grid circuit of the modulating tube together with a steady voltage from a battery. Owing to the non-linear relation which exists between the plate current and grid-voltage, the output current of the tube is not simply a reproduction of the alternating voltages applied to the grid. In fact, the modulating properties of the tube result from the interactions between applied voltages which this non-linear relation introduces.

It is evident that while the output current includes both the modulating current (here a sinusoid) and the carrier current, the amplitude of the latter varies in accordance with the instantaneous value of the former. Hence, even though the relatively low modulating frequency itself be removed by a selective circuit, its variations are preserved in the wave form of the higher carrier frequency.

As a result of experiments, it has been determined that speech of satisfactory commercial quality may be secured if the circuit is capable of transmitting all sustained alternating currents whose frequencies lie, let us say, between 200 and 2,000 cycles per second. These limits having been determined, the apparatus may then be designed on the basis of its meeting these requirements as to the transmission of sustained single frequencies. The information accumulated at voice frequencies can be applied directly to the solution of the carrier current problem and, incidentally, to radio telephony, provided we know what component frequencies are present in the modulated carrier wave and what relations exist between these components and the component frequencies of the modulating or voice wave. For a complete discussion of the analysis of a modulated wave into its component frequencies, reference may be made to a publication by Carson; and for its application to vacuum tube operation to Van der Bijl. While it is known that a modulated wave can be resolved into a large number of component frequencies, it is necessary to consider here only those components which are directly involved in carrier transmission.

From this it follows that every component frequency of a modulating voice wave is represented in the corresponding modulated carrier wave by two components, one of which is greater in frequency than the carrier wave by the frequency of the voice component, and the other of which is less by the same amount. We may, therefore, be certain that all of the essential components of the voice wave will be preserved if those components of the modulated wave are transmitted whose frequencies lie within two frequency bands, one of which extends from the carrier frequency plus 200 upward to the carrier frequency plus 2,000, and the other from the carrier frequency minus 200 down to the carrier frequency minus 2,000. These are known as the upper and lower side bands, respectively.

While the above discussion refers more specifically to the use of the vacuum tube as the means for effecting modulation of a carrier current, it should be understood that any device possessing a non-linear current-voltage characteristic will operate more or less effectively as a modulator.

Demodulation.—By the term "demodulation" is meant the process of reproducing the original low frequency modulating wave from the carrier wave upon which it has been impressed. Various methods of accomplishing this result have been known for many years, such as the use of the electrolytic detector of Pupin or of crystal detectors of various forms. All of these operate by virtue of their non-linear current-voltage characteristics. The instrument which has, however, come to be employed almost exclusively for this purpose is the three-element vacuum tube, and the following discussion presupposes its use.

The operation of the demodulating tube is exactly similar to that of the modulating tube, in that if voltages of two different frequencies are applied to its input circuit, there appears in its output circuit a complex current wave. When the output current wave is resolved into its components, we find currents identical with the two frequencies which had been applied to the input, one component whose frequency is the sum of the applied frequencies, one component whose frequency is the difference of the applied frequencies, and a large number of harmonics and sum and difference frequencies. The amplitudes of the two currents whose frequencies are the sum and difference of the applied frequencies are proportional to the product of the amplitudes of the applied voltages. When, therefore, the received modulated wave is applied to the demodulating tube, we may determine the frequencies and relative amplitudes of the components of voice frequency in the output circuit of the demodulator by considering the interaction of the various pairs of frequencies in the modulated wave.

Obviously frequencies in the voice range can occur in the demodulator output circuit only as the difference of two components of the modulated wave. If we subtract the carrier frequency from any component of the upper side band, the result is the original speech frequency which produced that component. The interaction of the carrier and the entire upper side band therefore reproduces all the components of the voice wave with their proper relative amplitudes, since the amplitudes of the side band components are proportional to those of the original voice components, and that of the carrier is the same for all of them. The reproduction of the original voice wave also results from the interaction of the carrier with the lower side band.

It is evident that since speech can be reproduced from either side band alone, there is no necessity for transmitting both. Accordingly, the selective circuits may be so designed as to transmit only one side band. As this effectively halves the range of frequencies assigned to each channel, its great importance is at once obvious.

It is necessary to consider the interactions between the frequency components of the side band itself, for if, in the case of telephony, the voice wave includes components of more than one frequency, each will be represented by a corresponding component in the side band. The interaction of two of these component frequencies, simultane-

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ously present in the side band, give rise to a component in the output circuit of the demodulator, the frequency of which is the difference between those of the corresponding two components of the original voice wave. Such currents will have a serious effect on the quality of the reproduced speech, if their amplitude is comparable with that of the reproduced voice currents. The amplitude of this distorting component is proportional to the product of the amplitudes of the two side band components, whereas the amplitude of each of the two components of the desired voice current is proportional to the product of the amplitudes of its corresponding side band component and the carrier. The reproduced voice current can be made large compared with the distorting current only by insuring that the carrier is large compared with every component of the side band. As a result of this, it follows that in order to secure good quality it is necessary that the greater portion of the energy applied to the demodulator consist of unmodulated carrier frequency.

The behaviour of the receiving apparatus—that is, the demodulating tube—to interfering currents, such as may be produced by induction from external sources of electrical energy, so-called static interference, etc., can be directly deduced from the above considerations. With properly designed selective circuits only those line currents whose frequencies lie in the range of the side band being transmitted can reach the demodulator. These can produce noise of voice frequency either by interaction with the currents normally associated with that channel or by interaction with each other. Unless the interfering currents are of greater amplitude than the carrier current, in which case commercial operation is impossible, the noise components of the greatest amplitude result from the interaction of the interfering currents with the carrier current. The noise current in the output circuit therefore bears the same ratio to the reproduced voice current as the interfering line current does to the side band current. It follows, therefore, that in designing a system it is the side band currents, in which are preserved the characteristics of the speech, which must at all points along the line be kept large compared with the extraneous disturbing currents lying within its range of frequency. This consideration has a very important bearing on the electrical design of apparatus operating on the carrier principle, whether dealing with wire or radio transmission.

While our discussion of modulation and demodulation has been made as concise as possible, it is evident from the foregoing that these two are complimentary processes. Modulation may be thought of as elevating the band of essential speech frequencies to a position adjacent to the carrier frequency, and the demodulation may be regarded as the process of restoring this band to its normal position in the frequency scale.

(To be continued.)

ELECTRICAL GOODS IN CHINA.

DEMAND FOR SMALL GENERATING SETS.

Our contemporary, *The Chamber of Commerce Journal*, publishes a Reuter note to the effect that figures just issued in relation to the trade of China show that there is a growing market for electrical materials. The demand for electric lighting in most cities in China where plants are working generally exceeds the supply, most of the plants being overloaded, which fact is leading to an increasing disposition among Chinese to lay in small private plants. This trade is now largely in the hands of Americans. In many cities there are merchants sufficiently progressive to install small plants for the purpose of lighting their own and several adjacent premises. The latest Customs report says that "there is a tendency in the more important establishments to install larger units, and whilst a few years ago 200 and 400 kilowatts were considered large, it is now common to install units of 1,000 kilowatts and upwards, and it is reported that a large number of orders have been placed for privately-owned power stations for the purpose of supplying power to cotton and flour mills." Although, says *Finance and Commerce*, a fair amount of this business has materialised, it must not be thought that the Chinese are falling over each other to get plants. In many instances it takes a good deal of nursing, but the business is there to be done. The importation of electrical materials into China amounted to 2.3 million taels in 1913, 5 millions in 1919, and 6.3 millions in 1920.

THE L.C.C. AND ELECTRICITY SUPPLY.

That the L.C.C. are getting nervous lest the Electricity Commissioners, as a result of the evidence at the London and Home Counties Electricity District inquiry, may consider it desirable in the public interest for Power Companies to take over a much larger share of the electricity supply business, seems to be implied by the publication of an additional Agenda Paper for last week's Council meeting, containing a recommendation by the Special Committee on London Electricity Supply as follows:—

> "That the Council is of opinion that should the Electricity (Supply) Bill, 1921, not become law during the present session of Parliament, a position may be created which will seriously prejudice the interests of London in regard to the question of electricity supply."

After recapitulating the history to date of the Electricity (Supply) Bill, and referring to the remote chances of the promised 1921 Bill being passed [as the tax and ratepayers have no desire to be saddled with further burdens], the Committee states:—

"The position that will arise, if the Government Bill does not proceed, will be a grave one. The County of London Co. may have obtained the requisite authority from Parliament to proceed with its Barking scheme, subject, of course, to the consent of the Electricity Commissioners under the Act of 1919. The company is in possession of a very large site at Barking acquired for the construction of this station, and the arrangements foreshadowed contemplate the erection of a station capable of development to a capacity of 600,000 kw. When it is realised that the present generating capacity of all the London electricity undertakings is only in the neighbourhood of 500,000 kw., and that the new station will be equipped in accordance with the latest knowledge and experience of electrical science, it will be understood to how large an extent the electricity position in London for years to come may be dominated by any arrangements that may be carried out at Barking. In expressing these apprehensions we wish to make it clear that we do not wish now to enter into the question of the technical merits of the Barking scheme. That is a question which is still before the Commissioners, and it will also be considered by the Select Committee of the House of Commons in a few days' time. In the absence, however, of any definite assurance from the Government with regard to the action which it intends to take to enable joint electricity authorities to be set up with the requisite powers contemplated by the Act of 1919, we consider that the position that now obtains is fraught with serious possibilities from the standpoint of the administrative and financial interests of the public, and that the solution of the London Electricity problem on the best possible lines, and unfettered by limitations, may be much prejudiced. For these reasons, and having regard to the fact that the Council may not have a further opportunity of expressing its views on the question before Parliament is prorogued, we have thought it right to report the facts somewhat fully, in order that the Council may be enabled to place on record, at this stage, its views as to the position that has arisen."

Blackpool.—In a discussion at the Trades Council an electrician described his calling as a disease rather than a trade. "You only need to have a lad with you three months," he added, "and he becomes a full blown electrical contractor."

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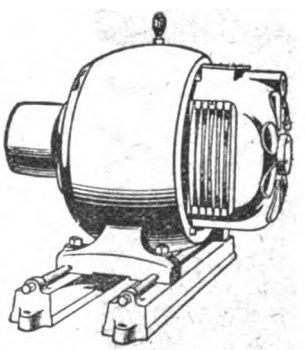


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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

We are accustomed to some dislocation of postal facilities at holiday times, but at this, the fiftieth anniversary of the "Statutory" or Bank Holiday, the business community is feeling the full effect of the postal restrictions introduced to effect "economies," so that the loss on the telephones and telegraphs may be offset, at any rate to some extent. The loss and annoyance due to discontinuance of Sunday collections in the provinces is this week so much aggravated that business might as well be suspended for the whole week. Perhaps the first step towards restoring the facilities for reasonably cheap and quick postal communication will shortly be made by the restoration of the reversion to the penny rate for postcards. If this step is taken it will be on account of the loss of revenue experienced by the great falling off in the number of picture postcards! Relatively a small matter as concerns industry as a whole, but one which is bringing home to the P.M.G. the fact that high charges do not necessarily bring increased revenue. Our hope is that he may thereby be led to appreciate the fact that high charges and poor facilities are handicapping, if not exactly killing, business as a whole.

The Postal Service.

In a recent judgment, in a test action, Mr. Justice Sargant decided that an indentured apprentice is entitled to receive the rate of wages provided for by the indentures, whether he be put on short time or be unemployed. The apprentice is entitled to no other relief. In the case in question the apprentice claimed full wages on the scale entered into in the indentures and to payments due under trade agreements entered into during the war. The judgment allowed him the former, but not the latter. It would hardly seem to have been necessary to go to a Court of Law to have this question decided, as it is surely a common-sense reading of the agreement entered into, and ought to satisfy both sides.

Apprentices' Wages.

I see that Mr. Alexander M. Thompson, Labour correspondent to the *Daily Mail*, has been having a trip to plucky and clear-sighted Belgium, where he obtained from a high official of the Belgian Trade Unions some interesting particulars concerning the state of the country. These particulars only bear out what I have written in these notes on several previous occasions, but in case there are a *few* readers of *Electricity* not included in those who read Mr. Thompson's "Daily," I propose to reproduce some of his remarks. One is that capable Belgian metal-workers before the war earned 5 fcs. (nominally 4s.) per day of ten hours, and now get 20 fcs. for eight hours.

Labour Abroad.

"The cost of living last September, according to the 'index number' was 276 for London, 375 for Paris, and 521 for Brussels. The figure is still very high—everything is much dearer than in London—but it has now declined in proportion with ours, and in the metal trades, at any rate, the present wage does seem to represent an increase over 1914. Yet M. Vandervelde himself has, in notable words, described it as 'a dangerous illusion' of working-class mentality to 'believe that, in a world immensely impoverished by the general lock-out of the war, it is possible for the mass of citizens to enjoy a higher standard of living than before the general stoppage of all useful production.'"

The secretary of the British Chamber of Commerce told Mr. Thompson that the Belgian wages were higher in value than they were, but that they were still much below the British standard. Moreover, the Belgian workers knew no "ca' canny," and their strikes, though numerous until the end of last year, had no importance. Further, German competition is keen owing to the rates of exchange, and the German workers are working even harder than the Belgians, but they are short of raw materials, and especially of tools, and this hampers their competitive powers.

On the other hand, a Charleroi manufacturer stated that Belgian industry is irrevocably doomed because the Belgian workers are, at the present rates of exchange, getting two and a-half times as much as the German workers in the same trades. If that be true of the Belgians, where do we come in? In spite of all, however, if we keep on in the direction we have turned to during the past few weeks, British industry should experience in the near future, if not a boom, a trade revival of some magnitude.

Elsewhere in this issue will be found the final instalment of our report of the seven weeks' proceedings before the Electricity Commissioners. It appears that petty jealousies and other uncharitable thoughts still prevail, especially with the Local Authorities and the L.C.C. If only the power companies were given a free hand, as we have stated on several previous occasions, something would be done.

London's Electricity.

ELEKTRON.

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THE LONDON ELECTRICITY SUPPLY PROBLEM.

(*Concluded from page* 405.)

The inquiry by the Electricity Commissioners closed on Friday, July 29, the concluding events being as follows :—

The evidence on behalf of the County of London Electric Supply Co., foreshadowed in our last report of the proceedings, was given by Mr. C. H. Merz and Mr. C. P. Sparks. It added almost a new interest to the inquiry.

Mr. Merz, of course, will be remembered as the originator of the idea of co-ordinating the supply of electricity in London, and his two historic fights in Parliament in 1905 and 1906 will not soon be forgotten by those whom duty or other interest led them to follow the proceedings. Mr. Merz's idea then was to form a company to erect one or more large generating stations and to supply the existing power stations with current at prices far below their then existing generating costs. Circumstances, of course, have altered considerably since then, but the fundamentals of the problem remain the same, and the several Bills promoted subsequently by the L.C.C. showed little variation from Mr. Merz's original proposal in 1905.

In October last, when the County of London Electric Supply Co. made an application to the Commissioners for authority to erect a 100,000-kw. power station at Barking, Mr. Merz was their chief expert, and again he came forward with what may be termed the "big" idea. The County Co. has two London areas, and a large one in the Romford district outside the County of London itself, and it is mainly in connecton with the development of the latter that the new power station is asked for. The L.C.C. and other interested parties seem to fear that this is an attempt to steal a march on them, and the Commissioners, at all times cautious and fair, have reserved their decision upon the application until the present inquiry is completed.

The main point upon which the Commissioners desired evidence from the County of London Electric Supply Co. now, however, was as to the wisdom of the two respective policies of erecting large stations at once, or, following the proposals of the L.C.C. and the others, to extend the existing power houses and carry on for a number of years by means of linking up, owing to the financial stringency of the times, which may be expected to last, some people think, for several years yet. As was to be expected, Mr. Merz is emphatically opposed to any such proposal, and the only hope he sees in obtaining an amelioration of the present admittedly unsatisfactory state of affairs is to build capital stations at once. The Commissioners themselves are painfully aware of the present unsatisfied demand in London. It is a fact that a 5,000-kw. electro-chemical demand could have been had in East London if the plant was available to give the supply, but it was not, and the business was taken to another district. Similarly, Mr. Merz spoke of being concerned with the transfer of works from London to the North-East Coast for the same reason. So emphatic was Mr. Merz in favour of erecting large power houses containing modern plant, that some of his expressions seemed to have almost given offence to the engineers engaged on the other side, judging by the subsequent cross-examination. Mr. Merz's idea of the next large power stations is that they will be combined with low temperature distillation plants, and that a certain portion of the generating plant will be arranged for operation by the oil so obtained. Moreover, he thinks they will be sufficiently large to warrant having their own distillation plants, and will not need to work in co-operation with the gas companies, as has been proposed in the scheme put forward by the nine companies.

The other feature of the proceedings was the calling of evidence, by the Commissioners themselves, from the Electrical Trades Union, and the Electrical Power Engineers' Association. The absurd suggestion was made by the representative of the former that out of a Joint Electricity Authority of 24 members, half should be representative of labour.

This completed all the evidence, and concluding speeches of counsel followed.

The best part of the last week was occupied with the winding-up speeches for the various promoters. An interesting if not important development took place on Thursday, July 28, when it was announced that the County of London Electric Supply Co. had come into line with the nine companies who are promoting a scheme, the result being that no opposition will come from that quarter to the Barking power station of the County Co. The nine companies say they are satisfied that the County Co. needs the Barking power house for its own particular needs, and both sides are agreed that the Beckton power station, which it is proposed should be erected in conjunction with the Gas Light and Coke Co., will be needed as well. It may be said that should the Commissioners decide to give the County Co. authority to erect the Barking power station, the Company has agreed to give any Joint Electricity Authority an option to purchase within seven years, and also to allow the Commissioners to fix the terms of such a purchase. At the same time, the County Co. has promised co-operation with the Joint Authority, should it be formed, but it does not want the Order authorising the Barking power station postponed until a scheme has been drawn up by the Commissioners.

Although there is this measure of agreement between the County Co. and the nine companies, there does not seem to be such friendliness between the County Co. and the L.C.C. Indeed, Mr. Craig Henderson, for the L.C.C., had some hard things to say of the County of London Co.'s attitude before the Commissioners. He said that whilst every other party to the inquiry had been quite frank and candid to the Commissioners, the County Co. had been playing a game of tactics and strategy. They had refused to give evidence until they were asked to do so by the Commissioners, and then they produced two gentlemen neither of whom were executive officers of the Co., both of whom were consulting engineers.

The concluding speeches revealed the many difficulties still confronting the Commissioners. Generally speaking, very little can be done except by agreement among the parties concerned, and in some respects this is far from being the case. No generating station, for instance, may be transferred to a Joint Electricity Authority without the consent of the owners, and serious difficulties have manifested themselves on this point both among the companies and the local authorities. The local authorities, or some of them, are not willing to transfer their stations at all, whilst the companies which are purchasable in 1931 by the L.C.C. are still negotiating terms upon which they shall part with their generating stations at once on the basis of an extension of tenure for their distributing rights. The local authorities, on the one hand, object to an extension of tenure of the companies' distributing rights, and do not agree with the suggested terms for the purchase of the generating stations, whilst, on the other hand, as already mentioned, there is not unanimity among those concerned in the Conference of Local Authorities to transfer their stations at all.

If the position may be put briefly, although the parties have come to a measure of agreement which was greater than existed when the inquiry opened, substantially the position is not very different from that which existed seven weeks ago. The inquiry, of course, has had the valuable effect of getting all the cards on the table and of enabling the position to be seen in its true perspective, but that agreement between the many people concerned, which it has been the earnest endeavour of Sir John Snell throughout to bring about, has not been effected. Moreover, the difficulties are not lessened by the withdrawal by the Government of the No. 2 Electricity Bill, although opinions differ widely as to that measure, which is certain to meet with opposition as regards certain clauses when it is reintroduced, as the Ministry of Transport has promised to, next session. On one point alone it may be said that without the No. 2 Bill Joint Electricity Authorities will have no financial powers, and that to a very large extent would stultify them at the outset. The nine companies who have promoted a scheme have taken advantage of that fact by offering, if their proposals are accepted, to put

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up the £1,050,000 necessary for the preliminary linking up. Here again, however, the nine companies have no promise that anyone else will co-operate with them, except the County of London Co., as already mentioned; and assuming they went forward it would have to be a limited scheme confined to these ten companies, again an unsatisfactory result. Any attempt to compel supply authorities to come into a general scheme would be resented, and everybody is clinging to their present rights with all the tenacity human nature is capable of, consistent with an avowed willingness to assist in every possible way.

The power companies in the areas adjacent to London and the neighbouring counties are all hostile, and really ask that the area should be the County of London. The counties put their case on administrative grounds, because they frankly fear the L.C.C. has an object in asking for the larger area, viz., to use it as a lever to extend the boundaries of the County of London later on. At the same time, they show just a tendency to want it both ways, and ask for county representation if a Joint Authority is formed.

It now rests with the Commissioners to prepare a scheme and issue an Order. Judging by Sir John Snell's closing remarks, it will not be done immediately, for he said the matter would be considered as the other pressing duties of the Commissioners permit. When that scheme is issued the success of it will rest largely on the extent to which the various undertakers and parties can agree. If they do not, there is not much hope in the position, but there is a genuine desire to come to some workable arrangement, and there is no reason to believe that every assistance will not be given to the Commissioners to that end. Nevertheless, it cannot be denied that a way out at one stroke seems almost impossible, and it may well have to be done by a series of more or less easy stages.

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Formerly, St. Marie's Church, Rugby, was lighted by means of gas standards (see illustrations) which, as an electrical installation has now been provided, are not now used, and will shortly be removed.

If the positions of the standards are studied, it will be seen that one or other of the lights interrupts the line of sight between almost any part of the nave and the chancel. Apart from the discomfort obviously caused by this arrangement, it had the further disadvantage of preventing the congregation from obtaining a clear view of the altar and pulpit. Another objection to the gas lighting was that at night the decorated ceiling and upper parts of the walls were left in darkness. From the architectural point of view, this is a very serious objection, because the whole interior design of a building of this character and period (Gothic) is based upon top lighting. In the daytime, of course, the church is lighted mainly by the clerestory windows. At night, however, the appearance of the interior was changed and distorted by the alteration in the plane of lighting.

The present installation at St. Marie's Church consists of Mirolux trough reflectors containing 40 and 60 watt Mazda vacuum lamps. The nave is lighted by fourteen troughs. These reflectors are fixed on the east side of the arched roof beams, between the clerestory windows. Several advantages proceed from this disposition of the light units. To begin with, neither the lamps nor reflectors



FIG. 1.—THE NAVE, LIGHTED BY MAZDA LAMPS IN MIROLUX TROUGH REFLECTORS.

are visible to the congregation. The light comes from the same level as the windows, and, like the daylight, illuminates the nave, from floor to ceiling. There is an ample illumination at pew height, and the congregation are able, not only to read with ease, but also to look towards the chancel without discomfort.

The chancel is lighted by means of six Mirolux troughs. Owing to the general eastward direction of all the lighting and the greater wattage employed in the chancel, the altar and reredos, and especially the rood cross, are more intensely illuminated than the body of the church. The lighting, as it should do, helps to focus the attention of the congregation upon these three predominantly significant features. This again is simply a night-time reproduction of the daylight effect aimed at by the architect.

The photographs used to illustrate this description were taken at night, solely by the light of the Mazda installation, and have not been retouched in any way. Mr. Shenton, electrical engineer of the Rugby U.D.C., must be accorded much of the credit for this installation. The wiring, which is on the surface, is carried out on the Henley wiring system, with twin lead-covered cables, painted to match their surroundings. This system, owing to the small section and flexibility of the wires, is very suitable for such an installation as this; in fact, the wiring is practically invisible. Control of all points is centralised in a distribution box fixed in the vestry. The whole of the work was carred out by Mr. Shenton's department under his personal direction.



FIG. 2.—THE CHANCEL, SIMILARLY LIGHTED, BUT TO A HIGHER INTENSITY.

Mirolux trough reflectors and Mazda lamps are manufactured by The British Thomson-Houston Co., Ltd., of Rugby and 77, Upper Thames Street, London, E.C.4, to whom requests for further information on the subject should be addressed.

Durban.—Two 500 kw. rotaries, switchgear and automatic controlling devices, and a small quantity of H.T. feeders are required. Tenders are required by Sept. 28. Specification, etc., Room 49, D.O.T.

Accrington.—On July 27, Col. Ekin, C.E., held an inquiry into an application to borrow £150,000 for electricity extensions. The Town Clerk said the Corporation had sold two old generating sets for £7,600, or £1,000 more than they paid for them. The outstanding debt on that plant was £2,600, but there was a balance on the sale. It was absolutely necessary the extensions should be sanctioned, for if anything went wrong with the existing plant, power consumers would be without current. They had buildings giving ample accommodation, distributing station and mains. Neighbouring townships were supplied at the same cost as their own townspeople. Mr. Clegg, Elec. Engineer, put the maximum demand for electricity at 3,900 kw. per week, but they anticipated a demand exceeding 5,000 kw. Mr. Blackburn, of Stalybridge, recommended a 6,000 kw. set and four pressure boilers with an evaporative capacity of 25,000 lb./hr. each. Mr. Wheelwright, Blackburn's Elec. Engineer, said Blackburn was willing to supply Accrington, but he did not think any alteration in price could be considered. Mr. Blackmore calculated if Accrington obtained electricity from Blackburn at the price Blackburn quoted it would cost Accrington £10,000 a year more than producing it under the present scheme. Blackburn Corporation's price was higher than that at which Accrington had contracted to supply consumers.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 123.

I desire a protective device for tripping a circuit breaker in the 20 to 33 volt generator main of a motor generator which is used for charging a battery of 12 cells. The breaker should trip under the following conditions:—

1. When a reverse current of 15 per cent. of the normal charging current flows through the generator armature.
2. When an overload of 50 per cent. flows for a predetermined period of, say, 10 minutes.
3. When the supply pressure to the motor falls to 50 per cent. or less of the normal supply pressure. The output of the generator is 300 amperes at 20 volts.

(*Replies to Question No. 123 must be received not later than August 27, 1921.*)

Answers to Questions.

QUESTION NO. 118.

What is the principle of operation of auto-transformers for starting induction motors? Is this method to be preferred to the ordinary starter, and is it cheaper?—"STATOR."

REPLIES TO QUESTION NO. 118.

The first prize (10s.) has been awarded to Mr. John Moray, No. 9, Woodside Terrace, Starling, Bury, Lancashire, for the following reply:—

The principle of the auto-transformer is as follows: In Fig. 1 *C* represents the winding of a choking coil, suitable for connecting to a supply pressure of, say,

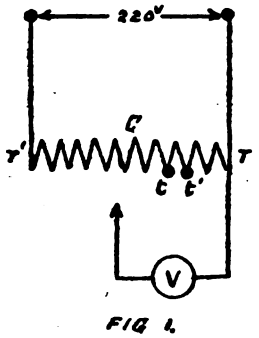


FIG 1.

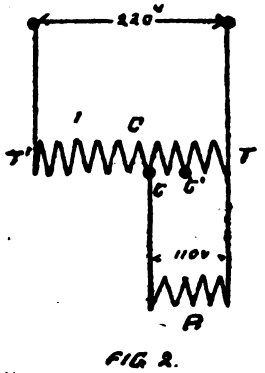


FIG 2.

220 volts, and *V* is a voltmeter with one side permanently connected to one terminal of the choker. If the wire be connected to the terminal T^1 of the choker, *V* will indicate the full supply pressure. If we make connection at some intermediate point, such as at *t* or t^1 we shall get something less than the full supply pressure.

It follows from the above that if we connect a circuit *R* to one terminal *T* and the midway point *t* of the choker winding, as in Fig. 2, the secondary circuit *R* will be fed at half the primary pressure. If the connection were made a quarter of the distance (measured by the number of turns) from *T*, *i.e.* at t^1, the voltage at *t* would be one fourth the supply pressure. In Fig. 2 the whole winding *T* to T^1 may be said to act as the primary, and the portion *T* to *t* as the secondary.

Assuming the losses in the auto-transformer to be negligible, the power in the secondary circuit is equal to that taken from the mains. Thus, if *Ip* and *Ep* equal primary current and voltage respectively, and *Ig* and *Eg* secondary current and voltage respectively, then $Ip\ Ep = Ig\ Eg$. $\therefore Ig = \frac{Ip \times Ep}{Eg}$. It has been shown above that *Eg* depends entirely upon the proportion of the total turns $T\ T^1$ included between $T\ t$. Hence: $Ig = Ip \times \frac{\text{Total turns between } T\ T^1}{\text{No. of turns between } T\ t}$. If the primary current in Fig. 2 was, say, 10 amperes at 220 volts, then the output on the secondary side would be 20 amperes at 110 volts. These figures show the usual function of an auto-transformer, namely, the conversion of a small current at a high voltage to a large current at a low voltage.

An auto-starter consists of a species of change-over switch working in conjunction with two auto-transformers.

The principle of the auto-transformer method of starting a three-phase induction motor is shown in

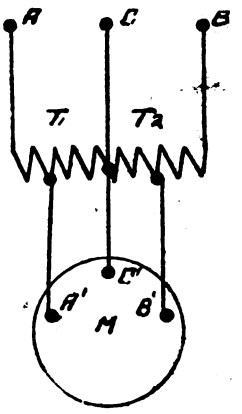


FIG 3.

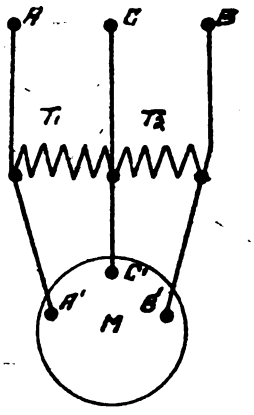


FIG 4.

Figs. 3 and 4, where *A*, *B* and *C* are the supply leads, and A^1, B^1 and C^1 are the terminals of the motor *M*. T_1 and T_2 are the two auto-transformers, which at starting are connected between the supply leads as seen at Fig. 3. In order that the amount of reduction of voltage may be changeable the "auto" windings are arranged with a number of loops or tappings; so that their points of connection *C*, *C* to the motor may, when being installed, be suited to the starting torque required. After the motor has run up to full speed, the connections are altered (by means of the switch) to those in Fig. 4 and the starter windings are put across the mains.

The auto-transformer method is employed for starting

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induction motors having squirrel-cage rotors. Motors having squirrel-cage rotors possess the disadvantages of taking a heavy starting current, and exerting a comparatively feeble starting torque. Therefore, this type of motor having the auto-transformer method of starting is to be preferred if the starting conditions do not demand a powerful torque.

The ordinary method of starting, that is, with the ordinary starter, is employed to start induction motors having wound rotors, and, as this type of motor is capable of exerting a very powerful starting torque, either type of motor, with its particular method of starting, should be employed according to the starting conditions to be met.

The former method of starting is the cheapest, if the starter and motor be considered inclusively, because induction motors having squirrel-cage rotors, are at once cheaper and simpler than motors with wound rotors having ordinary resistance starters connected to the rotor through slip rings.—"JOHN MORAY."

Various Items.

S.E. Lancs Electricity District.—The time for the lodgment of objections and representations has been further extended till October 31.

Exhibition Postponed.—The Co-partnership Exhibition which was to take place at the Crystal Palace this autumn has been postponed till next July.

Ball and Roller Bearings.—A sectional committee of the B.E.S.A. is to be set up to deal with the standardisation of ball and roller bearings for the engineering industry.

Electricity Districts.—The closing date for objections or representations, etc., has been extended to October 31 for both the East Midlands and Mid-Lancs Electricity Districts.

Mica.—An advertiser in Salisbury, Rhodesia, is very anxious to dispose of a large quantity of Mica, which he can supply direct from the mines to the consumer. For particulars see a small advert.

S.W. Electricity Orders.—The Ministry of Transport has confirmed special Orders made by the Electricity Commissioners in respect of the urban districts of Bedwas and Machan, Panteg and Risca.

Preston.—The Electricity Supply Company have recommended that Mr. J. A. Robertson should be asked by the Town Council to prepare plans for a new generating station in order that it may be submitted to the Commissioners.

Whitleyism.—The Whitley movement having entirely cut the ground from under the feet of any ideal there may have been in the formation of the unwieldly National Joint Industrial Council in April, 1919, the latter has now been disbanded.

Finsbury Technical College.—Although this training college is to be continued for a further five years at least, it is thought that the F.T.C. Defence Committee should keep in existence with an eye to the future and a public meeting will probably be called in October to consider the situation.

Greenwich Power Station.—The Highways Committee of the L.C.C. recommends acceptance of the following tenders for plant at the Greenwich power station and Holborn and Streatham sub-stations: — H.T. Cables, Western Electric Co., Ltd. (£38,485 15s. 1d.); seven 1,000 kw. rotary converters, B.T.-H. Co., Ltd. (£54,598); condensing plant, W. H. Allen Sons & Co., Ltd. (£17,893).

Improvements in Motor Car Fuel Consumption.—Mr. Arthur Tweedale, electrical engineer, of Poulton-le-Fylde, has invented a patent which taps and filters unexploded gases from motor vehicles and conducts them back to the engine. A test on a 20 h.p. Ford showed that with this economiser attached the consumption of petrol was at the rate of a gallon for 42 miles as against 18 miles without it.

L.C.C. Tramways.—The side slot conduit track in Kingsland Road is to be converted to the centre slot system at a cost of bout £46,500. The side-slot conduit was laid in 1906 as an xperiment, but experience has shown it to be unsuitable on account of the high check formed by one of the slot rails when its companion has been worn by tramcar traffic and the excessive accumulation of road debris in the conduit.

I.E.E. Meetings.—The Council have decided that, beginning with next Session, the meetings will be held on alternate Thursdays (except at times of public holiday) beginning with the first Thursday in November. At present they have under consideration the question whether the meetings should continue to begin at 6 p.m., as has been the case during the last few years, or whether the former hour of 5 p.m. should be reverted to.

Wrong Telephone Numbers.—According to Mr. Pike Pease (Assist. P.G.), subscribers are not charged for a mistake on the part of the operator providing that it was brought to the operators notice. Efforts, he said, were being made to find a machine that would register calls when put through, but up to the present no better system than that in force had been discovered. Penny-in-the-slot machines could be supplied to any user if he liked to rent one.

An Electro-Medical Treatment.—Electrical treatment, nvolving the ionisation of a zinc solution, has been shown to be suitable in many cases for curing chronic septic conditions of the ear, nose and throat, e.g., the oft neglected complaint of "running ear" can be cured by this means. A demonstration was recently given by Dr. A. R. Friel, aural specialist, Ministry of Pensions (London Dist.), and clinical assistant at the Royal Free Hospital, London.

Glo-clad Wiring System.—An interesting test on the water-tightness of the Glo-clad Wiring System, described in ELECTRICITY for July 15, has now come to our notice. A customer, wishing to find out whether the method of operating the Glo-clad switch effectively prevented the entrance of moisture into the switch case deliberately placed a switch in a bucket of water for a week, and at the end of this prolonged immersion it was found that no water at all had entered.

Accrington.—The Oswaldtwistle District Council, on July 21, expressed regret that neither Accrington nor Blackburn Corporation are prepared to supply the district with current, although small residential areas like Whalley were being favoured in this respect. The chairman said both Corporations had written stating that at present circumstances did not permit of the suggested extension of cable. As Accrington is pressing the Commissioners to approve of an extension scheme, the Oswaldtwistle Council decided to support this by writing a letter to submit to the Commissioners.

Electro Plating.—Quite a large number of the readers of this paper are, we believe, interested in the practical application of electro-plating, and to all such readers we would say, make a point of having in your possession a copy of the current issue of the Practical Electrician's Pocket Book. Not only does it contain a first-class chapter on plating work, but it also has a total of 520 pages of practical electrical data, and as it is recommended officially by the C. & G. authorities, it may be looked upon as an eminently useful and reliable work. Of all booksellers, 3s. net, or from Percival Marshall & Co., 66, Farringdon Street, E.C. 4, for 3s. 4d. net, post free.

Wanted—£1,000,000.—The ancient city of Bristol, whence came many adventurous and far-sighted traders, who in past times materially helped to lay the foundations of the present commercial importance of these small islands is, once again, after a period of comparative stagnation, making a bold bid to become one of our foremost cities and ports. It has a fine University where, among others, electrical engineers receive a valued and valuable training. Nevertheless, funds for extensions, as well as to meet immediate needs, are required, and these can only be obtained by voluntary contribution. An appeal is therefore being made for financial support, full particulars relating to which matter may be obtained in the form of an illustrated booklet from the Appeal Director, Mr. A. F. Shepherd, University Appeal Offices, 51, Corn Street, Bristol.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
PRACTICAL TRADE JOURNAL
AUGUST 12, 1921.

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THE GENERAL ELECTRIC CO., LTD.

ANNUAL GENERAL MEETING.

Magnet House was the scene of the Annual General Meeting of the G.E.C. on July 21, when Mr. Hugo Hirst, Chairman and Managing Director, opened his speech with the remark that when in 1889 he assisted as one of the founders in the formation of the Coy., with a registered capital of £30,000, he little dreamt that it would be his good fortune to direct its affairs for 32 years, or that it would grow into such a world-wide concern as it now is. After dealing with the balance-sheet (already referred to in our columns) he said:

"Year after year writers and speakers—who imagine that they are doing a service to labour—point to the growth of our results as if it were wrong to progress, or as if the results were extorted at the expense of the manual workers in our organisation. They either do not, or will not, understand that the results are due to joint efforts, that capital and brain workers are doing their share as well.

"Labour will be told we have made £160,000 more profits, but no attention will be drawn to the increase of capital—£2,000,000—which was essential to obtain the increased yield. Out of the total profits only £539,000 has reached the pockets of the shareholders who, had they invested £5,600,000 (which represents our total Debenture and Share capital) in British and Colonial Securities, would have had an income of at least £300,000, without risk of any kind. To secure to them the remaining £239,000, distributed in our case amongst 12,500 shareholders, we have been able to employ usefully 16,640 workpeople and staff. We have paid to them in wages and salaries £2,864,000. In addition to that I am sure we have contributed another £2,000,000 of wages to workers in other industries, spent on transport and on the raw materials required for our manufactures, such as coal, steel, copper, rubber, etc. In this year in particular we have besides contributed at least another million to the wages in the building trade alone, but the main benefit to all is that Capital and Labour have jointly created new values and added to the much-needed wealth of the country some £8,000,000 or £9,000,000.

"I make this point again and again to emphasise the difference between profits arrived at by an *industrial enterprise* in contradistinction to a *trading concern*: the former creates values, the latter exchanges values, and the benefit to the country of the latter may lie in its profits alone—therein lies the fundamental difference between trade and industry. A trader or distributor can do the same volume of business with only one million or one and a half million of capital. However, instead of employing nearly 17,000 workers, 90 per cent. of whom have to be highly skilled, he could have done this business with some 500 to 700 workers, only 10 per cent. of whom need be skilled. Nobody realises better than I the utility and the need of distributing houses. The reason for my comparison lies in my belief that owing to want of understanding industry does not receive the same support as trade from all shades of public opinion.

"This country is admittedly not self-supporting. To feed the people it is essential that we should import foodstuffs. We can only pay for these foodstuffs if Capital and Labour unite in creating yearly more values than we consume, but it should be borne in mind that the value of our finished product is not assessed by us but by the foreign buyer. Capital and Labour alike must realise this. They will have to be more modest in their demands in the future, or our country cannot meet its obligations. Unless we realise this, unemployment will grow, bearing in its trail hardship and misery."

He next referred to the Witton Carbon Works in connection with the Key Industries and Anti-Dumping Bill, pointing out that the total capital invested in the enterprise up to the outbreak of war was £40,000; the total losses incurred up to 1914, through the attacks of foreign trusts, were £78,000.

After the outbreak of war additional works were established at a cost of £50,000 towards which the Govt. contributed £30,000, which latter the G.E.C. were to pay back out of future profits. At the same time they gave the Govt. an undertaking to continue the supply of carbons throughout the war at pre-war prices. This promise was kept with the modification that towards the very end of the war a small increase in price based on the increase of wages dictated by the Govt. was allowed. The result was that the total accumulated losses to March, 1920, amounted to £115,000. Part of the works were now devoted to producing materials, invaluable for the automobile, printing, and paint industries, materials which before the war came from Germany.

Turning to the Leamington Glass Works—the financial results of which, owing to foreign competition, were always indifferent—Mr. Hirst referred to the fact that in 1914 special bulbs for the safety of our warships were at once required; bulbs for bombs, for vacuum flasks and other war supplies were at one time only available from these works, which, at the same time, kept alive at a critical period the lamp industry in this country. Further, the works enabled the Coy. to take a prominent part in the development of electric valves, which were used for a most effective defence against submarines and which now, in peacetime, are beginning to revolutionise all systems of communication, wireless telephony and other branches of electrical engineering.

The other works of the Coy., the Research Laboratories, and their industrial importance, were dealt with, and Mr. Hirst concluded on the note that *production* means increase of national safety and increase of national wealth.

MAGNET HOUSE.

Advantage was taken of the holding of the Annual General Meeting in the large lecture hall (seating capacity 350) for an inspection of the newly-opened head offices and showrooms in Kingsway. As an architectural achievement, Magnet House is excellent in conception and harmonious in design, whilst every care has been taken to cater for the comfort of customers and to ensure the prompt and accurate execution of orders.

The building covers a ground area of 25,722 sq. ft., and has eight floors including the basement. Each floor is divided into eight sections by brick walls, fitted with double iron fire-proof doors (to the number of 130) made by the Coy. at the Fraser and Chalmers Engineering Works, Erith. The doors are of several types, some of single and some three or four panels with hinged folding sections to allow of passing through without opening the whole door. All inter-departmental correspondence, as well as the incoming

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mail, is distributed by means of pneumatic tubes. Ventilation is secured by a network of ducts connected to a modern air-washing plant. Vacuum tubes are installed for cleaning. Artificial lighting is secured for 3,222 points. The Main Entrance Hall is of stately proportions, with stone walls, marble floor, wide marble staircase and massive bronze fitments. In the well of the staircase run two high-speed passenger lifts. In addition there are five other staircases serving the various floors of the building, as well as seven passenger and eight goods lifts, a complete system of hoists and runways for loading and unloading vans and lorries, and for handling bulky goods. The lift equipment, entirely by the Express Lift Co., Ltd., comprises a total of 23 machines of various types and forms a complete epitome of modern practice in lift design and construction.

In Fig. 1 are seen the contactor panels controlling the high speed lifts in the main staircase. These lifts are designed for a normal load of one ton and a maximum speed of 310 ft. per min. A second speed of 180 ft. per min. is also allowed for, the speed variation being under complete control of the lift driver. Each lift is driven by a 25 b.h.p. D.C. "Witton" motor, specially designed and manufactured for lift work at the Witton works of the G.E.C. The motors are fitted with interpoles and are compound wound, the series turns being used for starting and stopping only.

The operation of the contact board is as follows:—

Situated at the bottom of the panel are the main reversing switch and auxiliary closing switches, with two horizontal solenoids acting on a common plunger. The solenoids are connected in the "up" and "down" circuits respectively, and are operated directly from the car switch in the car. The reversing switch itself is the first switch operated, and is moved over to the "up" or "down" position by the excitation of the appropriate solenoid which pulls over the horizontal steel plunger. As soon as the plunger reaches the extreme position on one side or the other, the shortening of the air gap on that side strengthens the pull by from 30 per cent. to 40 per cent., and allows an end plunger to be attracted, operating the auxiliary closing switch which, in turn, energises the main closing switch solenoid above. It will be seen, therefore, that it is impossible to reverse the armature leads while the main closing switch is in the "on" position and current flowing in the armature.

The main rheostat is of a special type operated by gearing situated at the back of the controller, and driven direct from the car itself, so that the speed at which the starting resistance is cut out depends entirely upon the acceleration of the lift, and is therefore directly proportional to the load. The second speed is obtained by shunt regulation, the shunt rheostat being of the straight pull solenoid type operated through a relay under the control of the attendant in the car.

Two magnetic brakes are fitted to the driving gear, operated by solenoids energised from two independent circuits. The relays through which the brake solenoids work are also in independent circuits, so that the risk of both magnetic brakes failing to act is reduced to a minimum. In addition to the two magnetic brakes the controller is so designed that when the main closing switch falls to the "off" position and the motor is disconnected from the mains, the series turns are connected in circuit with the armature in such a way as to bring about a powerful braking effect. This helps materially to bring the car to rest smoothly and easily, an effect so essential to passenger lifts, especially those travelling at high speeds.

Easily renewable carbon contacts are fitted on every contact, and magnetic blow-outs are provided at all points where the circuit is broken. The resistances are all mounted on a frame at the back of the board, reducing resistances being inserted in all solenoid circuits to reduce the current in them to a minimum as soon as they have performed their work. The whole of the wiring on the controllers is carried out with solid copper wire, rubber insulated and asbestos braided to render it absolutely fireproof.

In the basement are the showrooms, where is to be seen a most comprehensive selection of electrical goods arranged with a full appreciation of the value of display as well as for the comfort and convenience of the visitor. The central apartment of the suite of showrooms is decorated in Georgian style and contains a large display of Georgian and modern fixtures of all types. In the French Room,

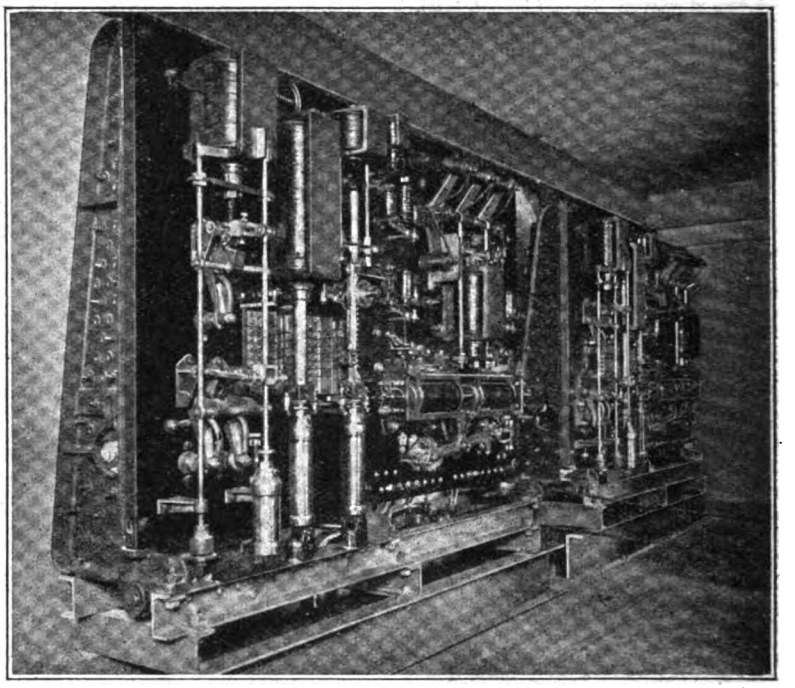


FIG. 1.—CONTACTOR PANELS FOR HIGH SPEED PASSENGER LIFTS AT MAGNET HOUSE.

which is tastefully decorated in white and vieux rose, is to be found a choice selection of Louis XIV. and Louis XVI. electroliers and brackets, together with French statuettes, bronze figures and table standards. The Adams section (Fig. 2), carried out in tints of wedgwood green, contains many chaste examples of brackets, pendants and electroliers in this style. Another period room is arranged as a Jacobean dining-room displaying chandeliers, lanterns, and table candlesticks of Tudor and Jacobean design, many of which are faithful reproductions of antique originals. The section devoted to alabaster ware holds an unrivalled assortment of inverted fittings, vases and pedestals.

Unique and artistic silk shades in great variety are arranged in an adjoining room, and the remaining department (Fig. 3) is devoted to an exhibition of domestic electrical appliances, including heating and cooking ware, irons and fans, vacuum cleaners, washing machines, etc.

On the opposite side of the vestibule is a large Industrial Showroom containing comprehensive displays of lanterns and fittings for factory and street lighting, ships' fittings and other items of electrical equipment for ships, switchgear, telephones, electric light supplies, cables and wiring materials and other products of the Coy., including a board demonstrating the new "Kingsway" Surface Wiring System. A certain amount of the wiring in the Industrial Showroom is also carried out by this system.

The greater portion of the ground floor is taken up by

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the sales counters which form a continuous line 140 ft long. Considerable storage accommodation is arranged behind the counters, and the bins can be quickly replenished from the main stockrooms on the upper floors by means of electric service lifts operated by a system of push buttons. The salesmen are in telephonic communication with their departmental stockrooms, so that in the event of any required article not being available at the counter, instructions can immediately be given for it to be sent down by these lifts. Under the counter runs a silent belt conveyor which carries customers' purchases to separate packing benches at one end; the salesmen are thus relieved of the task of tying up parcels, and are consequently enabled to attend to the requirements of customers in the most expeditious manner.

This belt conveyor—another product of Fraser and Chalmers Engineering Works—consists of a rubber-covered duck belt running over idlers mounted on a substantial steel frame. It is driven at a speed of 120 ft. per min. by a 2 b.h.p. "Witton" D.C. motor through one of the Express Lift Co.'s silent worm gears. The goods to be packed are placed in wire baskets fitted with wooden runners and pass over ball-bearing rollers to the packing benches at the delivery end.

In the van dock at the rear of the building are three cranes and runways for handling incoming goods. Cases are lifted from the lorries and lowered to the Receiving Department in the basement. Here the goods are unpacked, and distributed by lifts to the stockrooms on the fourth and fifth floors.

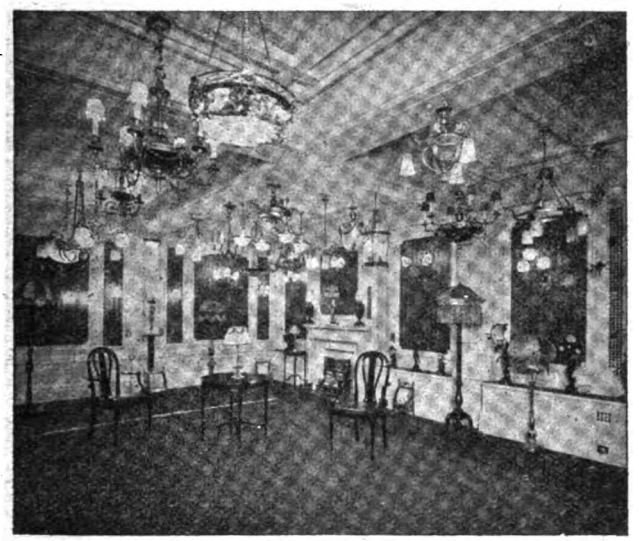


FIG. 2.—ADAMS STYLE LIGHTING FIXTURES SHOWROOM.

The first and second floors are principally devoted to administrative depts., nad a plentiful provision of signs in prominent positions direct the inquirer.

On the third floor is the commodious and well-arranged Despatch Dept. with its rows of bins and packing benches. To each dispatch clerk is allotted a definite section of the alphabet so that he always deals with all the orders of every customer in his section. Adjoining the Despatch Department is the Packing Room. Goods are delivered to the Despatch Department by goods or service lifts and the completed packages are lowered in special containers by combined cranes and runways into waiting lorries in the van dock below.

The stockrooms on the fourth and fifth floors are equipped with some 12,000 steel bins and are arranged to facilitate the work of looking out goods. The private telephone exchange, which has 50 incoming lines and 300 internal extensions, is situated on the fifth floor. The whole of the equipment was manufactured by the Peel Conner Telephone Works.

The offices of the Illuminating Engineering Dept., a large and well-lighted fixtures design office and a meter test room and workshop, are located on the sixth floor. Near by is the staff canteen fitted with "Magnet" urns, hot water calorifiers and hotplates. A large lecture hall is also situated on this floor. It has a seating capacity for 350 people, and is used for the social recreation of the staff, as well as for lectures on technical and commercial subjects.



FIG. 3.—SHOWROOM FOR DOMESTIC LABOUR-SAVING APPLIANCES.

The motor rooms for the various passenger and goods lifts are on the roof, which is reached by four emergency staircases. These motor rooms have been designed to afford every facility for inspection of the different drives and controls. The Company extend a cordial invitation to all their clients to visit Magnet House, and should any be in doubt as to the best means of reaching it, G.E.C. Pamphlet No. 2541, sent on request, will tell them all they want to know.

CARRIER CURRENT TELEPHONY AND TELEGRAPHY.

(*Continued from page 428.*)

Selection.—Electrical Filters.—When a number of one-way channels, each employing a different carrier frequency, are operated by superposition on a common line, each channel must be connected with the line through selective circuits which transmit only the range of frequency assigned to that particular channel. Not only must the demodulator assigned to a given channel be prevented from receiving from the line the currents of other channels, but the sending modulator must be prevented from putting on to the line currents of frequencies outside of its assigned bands, for, as was pointed out in the discussion of modulation, frequencies other than those desired are developed in the output circuit of the modulator, and if these currents were permitted to reach the line those whose frequencies fell within the transmission band of some other channel, would be transmitted to the demodulator of that channel through its receiving selective circuit.

As will be brought out later in the discussion of the behaviour of lines with respect to their transmission efficiency at carrier frequencies and with respect to crosstalk between adjacent circuits on a pole line, the most desirable frequency range is rather limited. For this reason, where it is proposed to secure a maximum number of channels simultaneously operating on a given circuit, it is necessary to make the frequency interval between the adjacent carrier channels as small as possible. The first limitation to the frequency separation between carrier fre-

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quencies is determined by the fact that, as has already been pointed out, the width of the side band must correspond to the voice frequency range; that is, even with ideal apparatus the carrier frequencies must have at least a separation of approximately 2,000 cycles per second. The ideal selective circuit which would permit this close spacing of frequencies is one which would transmit efficiently this side band, having a frequency range of 2,000 cycles, and would absolutely block off frequencies outside of this band. Because it is not physically possible to secure such ideal circuits, we are obliged to make a greater separation in carrier frequencies than that made necessary by the width of the side band.

The nearest approach to this ideal selective circuit, particularly for carrier operation at moderate frequencies, is secured by the use of what has come to be known as an "electrical filter." This arrangement was invented and thoroughly studied by Dr. G. A. Campbell even before practical carrier operation was made possible by the perfecting of vacuum tubes and the development of their use as oscillators, modulators and demodulators. Campbell's electrical filter is a network composed of inductances and capacities which transmits with a minimum of attenuation currents whose frequencies lie in a predetermined range and attenuates very greatly currents whose frequencies lie outside that range. While these filters may take a variety of forms to meet special needs, they are all alike in that the currents traverse a succession of meshes or "sections," the attenuating effects of which are cumulative. The discrimination against the frequencies which it is desired to exclude may be increased to any physically practical value by increasing the number of sections. As this filter transmits a band of frequencies, it has, for convenience, been termed a "band-pass" filter.

At this point it may be instructive to compare the performance of the filter with that of a pair of loosely coupled circuits resonant to a frequency in the transmission band of the filter. It is obvious from the attenuations of this circuit in the frequency range of the side band that such a circuit is very poorly adapted to the purposes of carrier telephony.

Referring again to the band-pass filter, it is of interest to consider the relation between its attenuation characteristic and the operation of the system. The form of the attenuation curve within its transmission range is important from the standpoint of the quality of the transmission of the carrier channel in which the filter is used. If the attenuation is uniform throughout the frequency range which the filter is designed to pass, the effect is merely the same as that of increasing the length of line by a corresponding amount, and the loss can be compensated for by amplification inserted somewhere in the system. If the attenuation is not the same for all frequencies within the band, as, for example, if it is greater at the edges than at the centre of the band, then the difference in transmission equivalent for different components of the side band will introduce a similar distortion into the over-all transmission frequency curve for various voice frequencies, as measured from the modulator input to the demodulator output. Such a distortion would manifest itself by more or less impairment in the quality of the telephone transmission.

Both the magnitude of the attenuation within the frequency band transmitted and the variation with frequency are dependent upon the dissipation of energy in the coils and condensers, as well as upon the choice of their electrical constants, so that the problem of securing filters of desired transmission characteristics has been largely one of obtaining reactance elements of high time-constants and of high accuracy and stability. For the capacities mica condensers are largely used. For the inductances a special core material of finely divided iron has been developed which has made possible toroidal iron coils, which are superior in time-constant to air core coils for frequencies up to the highest value used by us. At the same time they are more compact and have less stray field. Transformers having similar iron cores are also used throughout the carrier system.

As has been indicated, the attenuation of the filter outside of its efficient transmission band determines the necessary frequency separation between the side bands of adjacent channels and, therefore, to a large degree also the number of channels which may be operated in a given frequency range. For example, if channel *A* is operating through the filter, then the frequency band of channel *B* must be so chosen in the frequency range that the attenuation of the filter channel *A* for currents of the frequencies of channel *B* is at least as great as some value fixed by the cross talk requirements imposed on the system.

The attenuation outside of the transmission band is practically independent of the resistance of the coils and the dissipation in the condensers, but is determined almost wholly by the arrangement and values of the reactances employed in a section and by the number of sections. Numerous special arrangements have been devised for controlling the form of the attenuation curve and for giving to the filter an impedance best suited to the circuit with which it is connected. It has been found practicable to design filters which permit of operating with an interval of about 1,000 cycles between adjacent telephone channels; that is, 3,000 cycles between adjacent carrier frequencies.

In addition to separating the various carrier channels from each other, it is found convenient from an operating standpoint to separate within the toll offices the carrier frequencies as a group from the frequencies used for ordinary telephony and telegraphy. For this purpose the portion of the line which is used in common is connected with the carrier apparatus through a "high-pass" filter, which transmits all frequencies above a predetermined value (in this case above about 3,000 cycles), and suppresses all frequencies below this value (in this case below 3,000 cycles). Similarly connection is made with the ordinary telephone and telegraph circuits through a "low-pass" filter, which in this instance passes frequencies below 3,000 cycles and suppresses those above. Accordingly, the high-pass filter is designed to offer a high input impedance to currents of ordinary telephone frequency, and to have an impedance equal to that of the line for currents within the carrier frequency range. Correspondingly, the low-pass filter is designed to offer a high input impedance to currents of the carrier frequency range and to have an impedance equal to that of the line of currents of ordinary voice frequencies. The attenuation of the high-pass filter is small for carrier frequencies and large for voice frequencies, while the reverse is true for the low-pass filter.

A low-pass filter is also used in the output circuit of the demodulator to prevent currents of frequencies higher than the essential voice range from being transmitted to the subscriber.

(To be continued.)

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PAGES FROM OUR DESIGNER'S NOTEBOOK

WESTON ELECTRICAL INSTRUMENT CO. LTD

The

WESTON SYNCHROSCOPE.

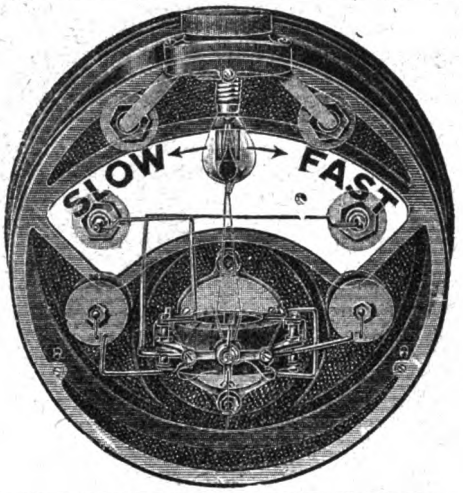
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The ordinary rotating field Synchroscope is simply a two-phase induction motor, the rotor of which carries the pointer and indicates by the direction of rotation if the incoming machine is fast or slow. This rotor is naturally heavy, and the friction at the bearings is very large compared with the friction between the pivots and jewels of a moving coil instrument. In addition, there is the friction of the sliding contacts, all of which tend to make the motion of the pointer jerky and uncertain except when it is revolving rapidly.

The Weston Synchroscope has none of these disadvantages, and is in every respect unique. The moving element consists of a very light dynamometer wattmeter movement carefully pivoted between hard sapphire jewels. After years of service the friction would not correspond to one quarter degree phase displacement. With the object of avoiding sliding contacts, the pointer merely oscillates although appearing to revolve, and this effect is accomplished by an ingenious combination of a synchronising lamp arranged to synchronise light and by so constructing the instrument that the pointer can only be seen when the lamp is alight. The apparent rotation of the pointer then indicates if the machine is fast or slow, the extent being judged by the speed of rotation, and when in synchronism the pointer remains stationary in the middle of the scale, being fully illuminated by the synchronising lamp.

The Weston Synchroscope is the simplest in construction, its moving system is the lightest known, and it has no sliding contacts or brakes. It is correct within one degree of true phase coincidence throughout a wide range of frequency and voltage, and it is impossible to make an error in synchronising with it. It shows at a glance to what degree the incoming machine is fast or slow, and the smooth and certain movement of the pointer inspires confidence.

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PHANTOM VIEW OF WESTON SYNCHROSCOPE.

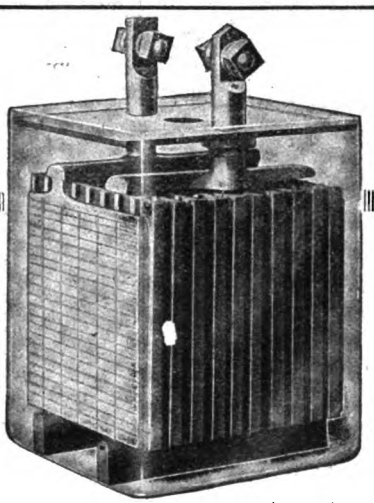
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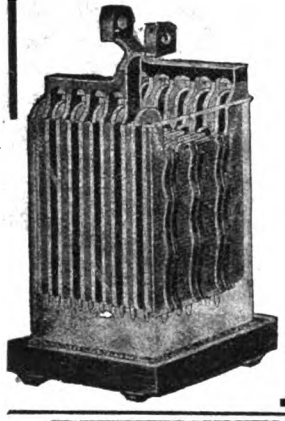
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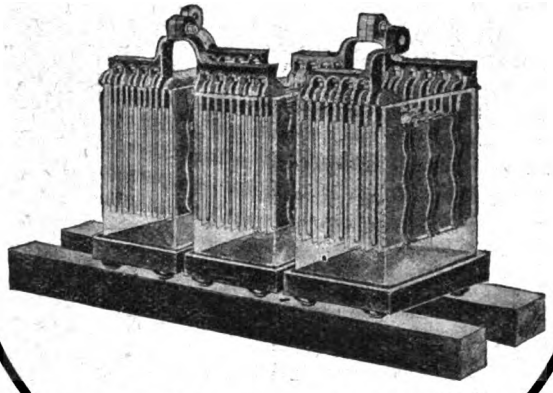
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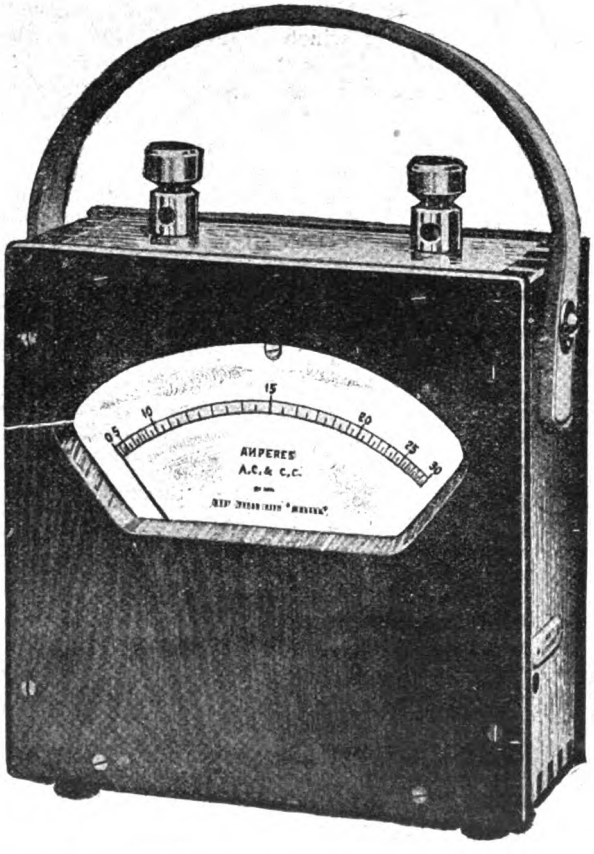


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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 6d stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 19-30, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Still at It.

With the coal settlement, and the acceptance of wage reductions by various sections of the industrial community, there is every hope of getting the wheels turning again, and perhaps winning back to that prosperity which marked our trade and industry before union fanaticism began to work such untold harm. Most of the trades unions are beginning to see reason, although their experience has been dearly bought, but there are still extremist factions at work, and the most vicious of all would unfortunately appear to owe allegiance to the electrical trades unions. I reported a case not long since where corporation workmen refused to connect up an installation which had been wired by the householder himself because he was not a member of their union, and now a similar incident has occurred in London, where the men employed by a provincial firm of contractors on a job in the London area have been warned off because they also were non-members of the E.T.U.

One is prompted to ask when Britain ceased to be a free land, and, further, when are the powers that be going to deport these industrial Bolshies back to the country of their origin, where they may indulge in Soviets and other things to their hearts' content. Surely any working man is master of his own destiny, and is quite capable of judging whether it is in his own best interests to join a union or remain independent. People in close touch with the engineering trades tell me that "ca' canny" is not only a widespread practice, but has the sanction and support of trade union rules. A case was cited the other day of a union which fines its members £1 for doing more than a fair day's work. Another influential union officially forbids work under any system of payment by results, and in order that there may be no doubt in any member's mind as to the object of the prohibition, it has framed a rule in which there is the following clause:—

> "No member shall provide a cycle of any sort for the purpose of locomotion to or from any of his employer's jobs or works during working hours, and members so doing will render themselves liable to be dealt with under this rule."

That's the kind of precept the British working man is expected to respond to in these days. It's well calculated to regain British industrial supremacy, isn't it? Don't cycle to and from your work, just walk—and walk slowly, too, so that you may charge up loitering time. Anyway, strolling leisurely along with one's hands in one's pockets, and incidentally in the employer's pocket at the same time, is far pleasanter and less tiring than getting on with the job, isn't it? Here is a sample of what the Dough-boys think of our trades union methods; it is extracted from an editorial in a Chicago contemporary:—

> "Although no one will deny the right of the working man to something more than merely a 'living' wage, it seems unfortunate, in view of the present crisis, that the power of the trades unions had been so strengthened by the withdrawal of men to the Army that they were able to dictate their own terms. Had they dictated their terms with the wisdom derived from a broad and sympathetic understanding of the needs of the community as a whole, the labour situation might have been much better than it is at present; but when a section of the community, which is notoriously short-sighted, tries to satisfy its own desires by making unreasonable demands, backed by the power to enforce them, disaster is sure to follow sooner or later. If the trades unions had insisted upon higher wages, and at the same time seen to it that their members worked longer hours when necessary, and improved, or at least maintained, the pre-war standard of efficiency, all might yet have been well; but with the higher wages came an insistence upon shorter hours, the tendency to slacking, and a lowering of the standards of work with which other countries, not alone England, are familiar.
>
> "Labour, as represented by the trades unions, has quite frankly and openly stated that, while it was master of the industrial situation, it was doing its utmost to better its position, even at the expense of other sections of the community; in other words, it was out to profiteer. Its arguments have not always been logical, or free from contradiction."

There, my trades unionist friends, you have in a nutshell the views of an outsider on your past policy of intimidation, and couched in very mild language indeed. If, instead of being a looker-on at the game, this frank American critic had suffered, as so many thousands of your own countrymen have suffered, through your extremism, I think he would have given vent to somewhat stronger and more condemnatory remarks.

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A Civil Service Veteran.

It is peculiarly apposite that, following my recent remarks on our telegraph and telephone system, there reaches me a report from far-flung Peru on the doings of a distinguished ex-civil servant, who, under the regulations of our own Post Office, is considered quite past his job. I refer to Sir William Slingo, the late Engineer-in-Chief of the Post Office, who, on retiring from office, took over the control of the postal and telegraphic services in Peru. When Sir William entered upon his new duties delays of from two to three days in the delivery of internal telegrams were common. The staff, too, although nominally working an eight-hour day, was found to be actually engaged ten or more hours per diem, according to circumstances, without overtime or compensations. Under Sir William's regime so great has been the change that on three successive days before the mail left Lima not a single telegram was left undelivered overnight in any part of the Republic. The staff also are being restricted strictly to eight hours' duty.

Here we have ample proof of the defects of our own postal and telegraphic service. As head of the engineering section, Sir William, a thoroughly capable organiser, was unable to bring about radical and much needed reforms on account of the restrictions and limitations with which he was hedged about. Released from British red tape as officially too old for further service, and given a free hand in a South American Republic, he is able to accomplish such far-reaching and extensive reforms in a similar service, covering an infinitely greater area, in such a brief period as has elapsed between his official retirement and his arrival in Peru. My hearty congratulations to Sir William Slingo; may his activities provide a much-needed object lesson to our own Government.

Sunday Trams.

Llandudno Council hold strong views on Sabbath day observance, and, when recently they received an intimation from the manager of the local light railway between Llandudno and Old Colwyn, stating that the company intended running a Sunday service between Rhos and Llandudno, they forthwith decided to refuse a supply of the necessary current, thus countering the company's proposal, which related to a section of the route covering private ground, and therefore immune from Council interference. Thus, if the respective residents of Llandudno or Old Colwyn wish to attend divine service in each other's boundaries for a change, they must either walk or choose some other means of transport. If I were in the company's shoes I should feel inclined to set up my own power station and tell the Llandudno Council to go to ——well, call it Llanfair P.G.

A Joke on the Gasworks.

The man who took two dead cats into the sausage shop at its busiest and said his boss would send along more as soon as possible is not in it with the Chief Constable of Peterborough, who has greatly amused the residents of that place by hanging an oil-lamp on a demonstration gas standard immediately outside the local gasworks. The standard, which now supports the rival old-time light unit, was specially erected to display the excellence of the gas company's product. When the supply of gas ceased, presumably due to the strike, the chief of police seized the opportunity, and it is now suggested that the oil-lamp should remain as a reflection on the services rendered by the gas company. Rather rough on the latter, but why not an electric fitting? It would serve as a foil to Liverpool, where gas standards illuminate the vicinity of the electric power station.

The Lighting of Country Roads.

With the enormous growth of motor traffic, both heavy and light, the headlight problem has been a very difficult one to solve. To drive safely after dark over the average country road, on nights when the moon is conspicuous by its absence, it is essential that powerful headlights, capable of throwing a concentrated beam several hundred yards in advance of the vehicle's progress, be carried on every car. Not only do these dazzling lights annoy and endanger other traffic and pedestrians, on account of their temporary blinding effect, but to car drivers also they constitute a potential source of accident whenever two vehicles have to meet and pass one another head on.

Every sane motorist accustomed to night driving appreciates the drawbacks of the headlights he is forced by circumstances to use, and many clever brains have been hard at work for some months past endeavouring with some measure of success to mitigate the nuisance. Powerful headlights are unnecessary in towns and populous areas where the streets are illuminated in some degree after dark, and most drivers are sufficiently conscientious to switch off their headlamps for town work, only making use of them when driving along country roads. In any event, the use and disuse of headlamps is only a compromise, and the real solution of the problem lies in economical and efficient illumination of the main roads themselves after dark.

Nor is this such an impracticable suggestion as would at first sight appear, for the provision of proper lighting for country roads is to receive careful consideration in the construction of the "Ideal Section" of the Lincoln highway in America. A number of important main highways have been lighted for certain distances through the open country, but it is doubtful if a careful and detailed scientific study of the problem involved has as yet been made. The methods employed to light such highways as have been illuminated have varied with the ideas and finances of the many scattered counties and communities undertaking such lighting. The results have frequently been disappointing. In fact, many drivers have complained that some methods of lighting rural highways defeat their own purpose in making the highway even more dangerous for night travel than if it were left totally dark. Certainly the provision of a series of brilliant lights at intervals over crowded routes of travel does not answer the purpose. Such lights, if placed at improper heights, shine in the drivers' eyes, or on rainy nights are reflected from the pavements. It is fraught with much promise of ultimate success that the

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experiments in connection with the lighting of the "Ideal Section" of the Lincoln highway have been entrusted to Mr. W. D'Arcy Ryan, chief illuminating engineer to the General Electric Company of Shenectray, which has such boundless research facilities and experience of similar lighting problems. I shall await developments with much interest, and in the hope that our own highway authorities will not lag too far behind in meeting this really pressing need of the times we live in.

ELEKTRON.

ANOTHER BRITISH MUNICIPAL CONTRACT GONE ABROAD.

The Highways Committee of the L.C.C. have recommended the acceptance of a tender at £45,000 submitted by Messrs. Brown, Boveri and Co., Ltd., a Swiss firm, for an 8,000 kw. turbo-generator in connection with the extension of Greenwich power station. The recommendation has been ratified, as although British firms were asked to amend their tenders on the understanding that they could obtain their raw materials abroad, the lowest acceptable tender was some £8,000 above Brown, Boveri's tender. The L.C.C. saves nearly 16 per cent.

In a letter addressed to the Chairman of the L.C.C., Mr. D. A. Bremner, Director of The British Engineers' Association, argues that the L.C.C. makes its purchases with public funds for the purpose of rendering public services, and if the purchases be made in this country the money expended remains here. In the case of an order for a turbo-generator, at least 80 per cent. of the purchase price would be distributed amongst our own people in the form of wages and salaries. If, on the other hand, the purchase be made abroad, the money leaves this country, and in something like the same proportion is distributed to foreign labour and salaried officials. *Our cost of manufacture is relatively high because of the larger amount of purchasing power demanded by our workers in return for their production of a given commodity value.* But the people of this country, who are themselves responsible for the high cost of manufacture, owing to their defiance of sound economic principles, should ungrudgingly pay the higher prices for the products of the home industries, which are the primary source of any well-being they have ever enjoyed or ever will enjoy.

Mr. Bremner further says: "A high standard of real wages cannot continue to co-exist with discrimination, on the part of the spender, against dear home products in favour of the lower price products of other countries where the wages cost per unit cost of value produced is substantially lower. The two conditions are mutually exclusive."

In a letter to the Press, Mr. Hugo Hirst, Chairman of the General Electric Co., Ltd., says:—

"Unfortunately the British manufacturer is still bound by the high wages fixed during and immediately after the war. The engineers are still contesting the reduction which employers suggested early in the year as the minimum required to enable them to compete. No blame can therefore be attached to the manufacturer. But does the public realise that the alleged saving is chimerical? I maintain that the country loses £25,000 by this work going abroad —£15,000 to £18,000 in direct wages to engineering trades and probably another £10,000 in wages spent on raw materials. This £25,000 represents a year's wages of 100 workers at £5 a week. The British worker has lost the work; the foreign manufacturer gets a fine advertisement, and if he chooses to use German material he can even make a big profit. The only benefit to the British manufacturer will be the prospects of a higher rate of contribution to the unemployment funds."

Our view is that a few transactions of this nature will do more than months of talk towards showing the "worker" that nominally high wages are not necessarily the same thing as high purchasing power.

THE INSTITUTE OF METALS.

A number of interesting papers on metallurgy and many visits to works as well as social entertainments are on the programme for the Autumn meeting in Birmingham from September 21 to 23. The meeting will be more largely attended by the Institute's 1,400 members than any previous meeting. On the present occasion the Institute will be paying its first return visit to its old home in Birmingham, which it left for London in 1908, when the membership was only 200.

In view of an expected considerable accession of new members, a special council meeting is being held in London on Sept. 7 for the purpose of considering applications for membership. All applicants for membership whose forms are in the secretary's hands before noon on Sept. 7 will be entitled to take part in all the proceedings in connection with the Birmingham meeting. Application should be made to Mr. Shaw Scott, Sec., 36, Victoria Street, S.W.1.

ANSWERS TO CORRESPONDENTS.

G. H. FIRTH (Cleckheaton).—You will be able to reduce the speed of your motor by inserting resistance in the line of your 230 volt supply. The amount of speed reduction will depend upon the amount of resistance inserted although not in direct ratio. We would point out, however, that the insertion of resistance will mean a reduction of power, and you must be careful to ascertain that the motor speed (since it is a shunt motor) is not reduced when you place it on load at the reduced speed. In other words, if there is a decrease of speed when it is placed on load, the back electromotive force will be reduced and the armature coils will be in danger of burning out. We would advise you to look into the matter from the mechanical end of the machine, and see if an alteration can be made and so prevent the motor from running under conditions for which it was not designed.

UNWATERING OF PENCAITLAND COLLIERY.

Scottish collieries, especially in the Lothians area, suffer greatly from water, and during the recent mining crisis many were soon flooded. This was the fate of Pencaitland Colliery (Woodhall Coal Co., Ltd.), where the pumps were completely flooded in a few hours. It was decided on April 18 to unwater the pit electrically, and a petrol engine of the "Ricardo" army tank type was obtained from stock through Messrs. Peter Brotherhood, Ltd. This engine was capable of developing 175 b.h.p. at a speed of 1,200 r.p.m. A D.C. motor which was in stock at another colliery, and capable of developing 210 b.h.p. at 1,200 r.p.m. at 460/511 volts was converted into a generator and coupled to the petrol engine. Messrs. Brash and Russell, electrical engineers, Glasgow, undertook to supply switchgear, cables and shaft cleats, and Messrs. British Electric Plant Co., Alloa, undertook to supply a motor driven centrifugal pump capable of delivering 1,000 gallons per minute against a total head of 240 ft.

The cables, cable cleats and switchgear were delivered on May 2, and on the evening of the 6th the engine and dynamo with bedplate arrived from Alloa, where the two units were combined upon a common bedplate and the dynamo adjusted and coupled to the engine.

On the evening of May 26 the shaft cable was stretched out along the surface. The manager undertook the duties of the winding engineman, the under-manager with the commercial manager—Mr. McGregor—and consulting engineer, Mr. A. B. Muirhead (Messrs. D. Selby, Bigge and Co.), went down on the top of the cage to guide the cable in the shaft, while Mr. Jas. Reid (chairman), Mr. R. E. Edwardes (of Messrs. D. Selby Bigge and Co.), and Mr. Robert Russell (of Messrs. Brash and Russell), the contractors, took charge at the surface, and in one hour twenty minutes both cables were installed securely in position.

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The engine and dynamo were fixed in position on May 6. The pump, supplied in record time by the British Electric Plant Co.—for which Mr. Murdoch and his staff at the works are to be complimented—arrived on May 10, and on the 13th a preliminary run was made. Pumping operations started on May 14, and after a few stops for the adjustment of various details, giving about 48 hours actual pumping, the plant was started up at 3 a.m. on the morning of May 17 and ran right through until 5 a.m. on the 25th—194 hours steady run—by which time the water had been lowered 20 ft. in the shaft. During this period the manager, assisting also as winding engineman, was in constant attendance at the pit.

A stop of 57 hours occurred while the pump was being lowered down in the shaft—it should be explained that the pump was of the ordinary horizontal type with motor coupled direct through a flexible coupling. The pump and motor were mounted on girders which were laid across the beams in the shaft.

The under-manager worked right through the 57 hours, and with his assistants—mostly clerical men—got everything ready, and the pump was re-started at 1.50 p.m. on May 27.

By June 6th, at 11 a.m. after a continuous run of 237 hours, the water was so lowered that the suction lift on the pump was 26 ft., although by this time there was still 7 ft. of water over the permanent pumps in the pit, and it was decided to lower the electrical pump another stage in the shaft. This was proceeded with and the work occupied 71 hours; a re-start was made at 10 a.m. on the morning of June 9, and the unwatering proceeded steadily until June 11 at 6.30 p.m.—56½ hours—when the plates in the pit bottom were free from water.

The following notes in connection with the work of unwatering this mine are interesting:—

Total number of hours run	525.5
Total gallons of water pumped	32,130,000
Total tons of water pumped	143,437.5
Average electrical h.p. required per hour	106
Petrol consumption per hour in galls.	10.5
Total gallons petrol used	5,517.75
Efficiency of pumping engine b.h.p. to w.h.p.	57.75
Lubricating oil used per hour in galls.	.5
Total gallons lubricating oil used	262.75

	£	s.	d.
Cost of petrol per hour	1	12	5
Cost of lubricating oil per hour	0	3	7
Total cost fuel and lubricating oil per hour	1	16	0
Cost per 1,000 gallons water		7.2d.	

This method of unwatering, says *The Mining Electrical Engineer*, was looked upon as an experiment, and it is felt that the enterprise has been more than justified by the rapidity with which the mine was unwatered and thus got ready for opening up on the conclusion of the strike; while from the point of view of cost of operation, if the work had been carried out by means of steam pumps in the shaft the cost of operating the boiler plant and pumps would not have been appreciably less, owing to the conditions which prevailed during the strike period.

"TERRA-GRIP."

The desirable practice of inviting the assistance of dealers and users in one form or another when placing a new device on the market was adopted by Simplex Conduits, Ltd., in connection with the provision of a suitable name for their new conduit continuity system. Through the medium of their quarterly publication, *Installation News*, the company offered five guineas to the originator of the accepted word. Within a week or two over 300 suggestions were received, from which the word "Terra-Grip," as submitted by Mr. B. W. Southgate, of 26, Old Heath Road, Colchester, has been selected. This word describes the system well, as a most efficient grip is assured by means of the hard steel cup-shaped screw, which is inserted in a tapped boss provided with every outlet. When driven home the cup-shaped nose of the screw expands over the conduit, and in doing so automatically scrapes off the enamel. Further, it is locked in position, thus making it impossible to loosen under vibration.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 123.

I desire a protective device for tripping a circuit breaker in the 20 to 33 volt generator main of a motor generator which is used for charging a battery of 12 cells. The breaker should trip under the following conditions:—

1. When a reverse current of 15 per cent. of the normal charging current flows through the generator armature.
2. When an overload of 50 per cent. flows for a predetermined period of, say, 10 minutes.
3. When the supply pressure to the motor falls to 50 per cent. or less of the normal supply pressure. The output of the generator is 300 amperes at 20 volts.

(*Replies to Question No. 123 must be received not later than August 27, 1921.*)

Answers to Questions.

QUESTION No. 118.

The second prize (5s.) has been awarded to "M.M." for the following reply:—

There are three general methods of starting squirrel-cage motors: (i) by resistance in the stator circuit, (ii) by auto-transformer, (iii) by means of a star-delta switch. The object of each of these methods is to prevent an excessive current being taken from the mains when starting up the motor.

By the insertion of resistance in the stator circuit, current is reduced, but torque exerted by the rotor is very poor. Torque varies as the square of the voltage impressed on the stator.

An auto-transformer has one coil wound on a laminated iron core with one, or more, tapping taken from the winding. Thus, suppose there is one tap, there will then be three leads from the auto-transformer, the end connections and the tap. Two voltages are then available, the total drop across the auto-transformer and that between the tap and one end. For a three-phase motor two auto-transformers are employed, the third supply main going direct to stator.

The large current taken by stator only flows through part of the auto-transformer winding; other part of winding taking primary current only. This means a considerable saving in copper.

With this increased current we have a reduction in voltage at terminals of the stator. Thus there is a much greater current in the stator windings than is drawn from the supply.

Neither the star-delta arrangement nor the auto-trans-

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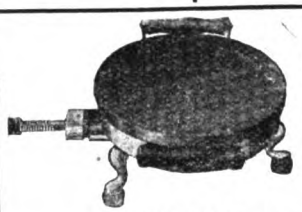
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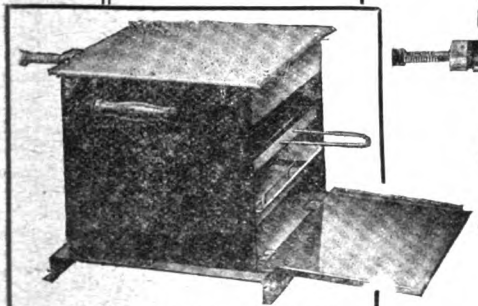
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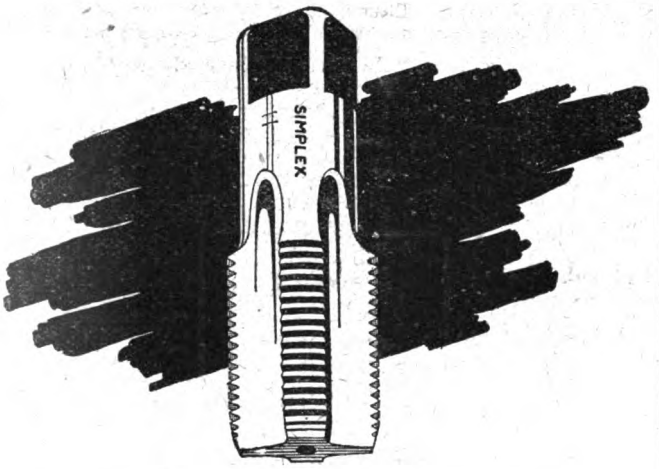
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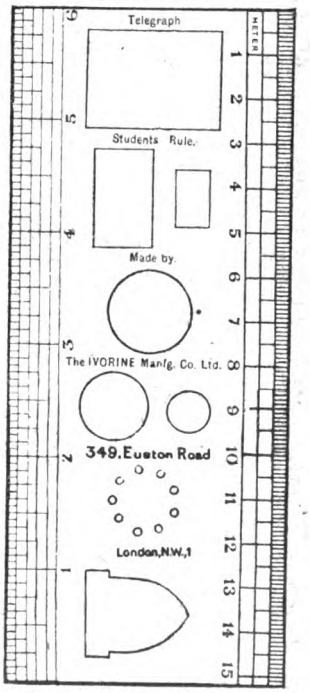
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former give nearly so great a torque as that obtainable from a slip-ring motor with regulating resistances.

The squirrel-cage rotor is considerably cheaper to make than a wound rotor provided with slip-rings.

Exact present prices are difficult to give, but relative prices for ordinary starter, star-delta switch, and an auto-transformer are approximately the same for each.—M.M.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

THE ELECTRICAL TRADES DIRECTORY, 1921. (Benn. 25s. 9d. net.)—Needless to say, we again extend our annual cordial welcome to the Blue Book which has proved its value to all sections of the electrical trades for so many years past. In the handbook section there is a vast amount of technical, commercial, legal and other information relating to the various branches of the electrical industry, including many electro-technical tables and data, import duties leviable on electrical machinery, telegraph and telephone statistics, particulars of engineering societies, Government departments, etc., which are worthy of reference. In the Digest of the Law relating to Electricity Supply (page 266), the numerous changes made by the Act of 1919 are given as well as the latest orders of the Ministry of Transport and the Electricity Commisioners. The above remarks apply to the handbook section of this invaluable directory. So far as concerns the alphabetical sections which cover Great Britain, the British Colonies and foreign markets, these contain the name and address of practically everyone associated with British electrical engineering and allied industries, as well as of the central stations, both municipal and company, together with details of system and supply, and names of chief officials, etc. Altogether the book is indispensable to those who are engaged in the electrical industry in Great Britain.

Trade Notes.

J. W. Barnard (4, Great Winchester St., E.C.2), manufacturer of electrical accumulators for motor cars, motor boats and other purposes at 45, Great Ormond St., W.C.1, announces prompt free collection and delivery of accumulators of any make by motor van in the London district for repairs.

Reduced prices of "Sunco" electric fires are given in an illustrated folder issued by the **Sun Electrical Co., Ltd.** (118-120, Charing Cross Road, W.C.2), who intimate that they will be pleased to send a copy to any interested readers.

The Magneta Time Co., Ltd. (14 and 16, Carteret St., Westminster, S.W.1), have acquired control of the Standard Time Co., Ltd. (19-21, Queen Victoria St., E.C.4). and the "Magneta" directors have personally acquired control of the Lowne Elec. Clock and Appliances Co., Ltd. (198, Bromley Road, Catford), and of the Silent Electric Clock Co., Ltd. (192, Goswell Road, E.C.12). By this means cost of manufacture will be reduced, and the Catford Works are being considerably enlarged and additional up-to-date plant is being installed. The company makes electric and mechanical clocks, time signal gear, synchronising apparatus, air meters, wind vanes, etc. The personnel of the various businesses enumerated above will remain as hitherto.

The Jackson Electric Stove Co., Ltd. (143, Sloane St., S.W.1), have appointed Messrs. Witty & Wyatt (Cardiff), Ltd., of 5, Burt Street, Clarence Road, Docks, Cardiff, as their Agents for Wales and the West of England. Messrs. Witty and Wyatt will hold a showroom stock and have same on view for the benefit of clients in that area. The arrangement with the previous agent, Mr. Wm. Blogg, of 8, Park Place, is now terminated.

Messrs. Geo. Ellison, of Perry Bar, Birmingham, have just recently issued a very interesting new catalogue, No. 60, dealing with their latest type of Electric Control Gear. We strongly advise interested readers to make early application for copies.

We have received from **"Z" Electric Lamp and Supplies Co., Ltd.** (73, Newman St., W.1), a small show or counter card provided for the use of suppliers of the "Electrolux" suction cleaner.

A revised edition of the D.C. motor starter, speed regulator and shunt resistance catalogue issued by the **City Electrical Co., Ltd.** (1, Emerald St., Theobald's Rd., W.C.1), is now available. New features are improved combined starter regulators and a new form of low priced inching starter, specially designed for use in the printing and allied trades.

Benjamin Electric, Ltd. (Brantwood Works, Tottenham, N.17), notify that on August 1 the 15 per cent. advance on the lighting fittings and specialities shown in Sections 1, 2, 3, 4 and 7 of their Cat. No. L6 were withdrawn. There is no advance in Sections 5 and 6, but the trade discount on section 5 is increased. Similar reductions in price also hold with regard to the goods listed in Benjamin publication, "Productive Illumination for Factories."

British Insulated and Helsby Cables, Ltd. (Prescot, Lancs), have published a new general descriptive catalogue, in which reference is made to the formation of the Company in 1897. It was the original manufacturing company in this country of Paper Insulated Lead Covered Cables, and eventually took up the manufacture of copper wire, using a patented annealing process obviating the use of acid after the initial pickling. Other well-known manufactures include aluminium sheet, joint boxes and cable accessories, overhead equipment for trams and railways, condensers, welding machines, etc.

Bedesco, Ltd. (20, Bucklersbury, E.C.4), have produced for the use of dealers in cycle and motor-cycle lighting sets an effective window streamer and folder (for overprinting). The design shows an owl and bears the remark, "Wise Eyes See in the Dark." As regards the set, the dynamo is fitted with ball bearings and is driven off the rim of the rear wheel. Its output is 1 amp. at 6 volts, and it lights both front and rear lamps.

Harwell, Ltd. (2, Bayley Street, Tottenham Court Road, W.C.1), inform us that they are controlling the sales of Semaphore dry batteries and cells. They are also sole selling agents for insulating materials manufactured by the Improved Solidite Co., Ltd., and at the same time they are representing Grothe and Sons, of Cologne, for electric bells, lighting accessories, medical coils, toy motors, etc. Leaflets on request.

Mr. A. L. Tester, A.M.I.M.E., who joined the firm of **Williams and Williams, Ltd.** (Engineers and Metal Casement Manufacturers), of Chester, towards the end of last year, has just been appointed sales manager to Mr. B. A. Williams, managing director. Mr. Tester will control the Sales Organisation from the Sardinia House office in Kingsway, W.C.2. and will give the same personal attention to the requirements and wishes of architects and builders as characterised his work with the steam boiler trade in pre-war days when chief engineer to Messrs. John Thompson, of Wolverhampton. It is the practice of Messrs. Willams and Williams to attach expert casement fitters permanently to each branch office, so that every window can be adjusted and left in working order. "Reliance" Sashes are suitable for all factory buildings, including especially engine and power houses.

Blackpool.—Mr. G. Morrison, electrical engineer, Birley St., Blackpool, has obtained the contract for the electric installation for the Crook (Durham) Housing Scheme, the 228 houses being erected by Messrs. J. Parkinson & Sons, Ltd., of Blackpool.



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Various Items.

Finance.—The Directors of the Yorkshire E.P. Co., Ltd., propose to pay an interim dividend of 3 per cent. for the half-year ended June 30th last.

Blackpool.—St. Anne's Council have appointed a committee to confer with Lytham Council regarding an immediate supply of current to that town.

Henley's.—The Directors of W. T. Henley's Telegraph Works Co., Ltd., have declared a dividend on the Preference shares at the rate of 4½ per cent. per annum, less Income Tax, for the half-year ended 30th June last, also an interim dividend on the Ordinary Shares of 1s. per share, less Income Tax, both to be paid on 1st September next.

Portrush.—The Lighting Committee has recommended that application be made to the Electricity Commissioners to amend the Portrush Lighting Order, so as to provide that the maximum price for any amount up to 20 units be £1 6s. 8d., and for each unit over 20 units, 1s. 4d. As the Order stands, the maximum amount that the council is allowed to charge is 8d. per unit.

Cheaper Electricity.—Small price reductions have been notified by a few supply authorities, including St. Pancras and Willesden. Doubtless this will soon become more or less general except in the case of small undertakings, which unfortunately have often been run at a loss during the War, and have only recently obtained powers to increase their charges. Many of them have huge losses to wipe off.

Powell Duffryn New Enterprise.—Operations for the sinking of two new pits near to Deri Station have commenced, and it is expected that steam coal seams will be reached at a depth of 500 yards. The shafts are 20 ft. in diameter, and their full winding capacity approximately 4,000 tons per day. The whole of the machinery is electrically driven from the company's generating system, the winding engines being driven by 1,600 h.p. A.C. motors.

Electrolytic Disinfecting Fluid.—The annual report for 1920, by Mr F, W. Alexander (M.O. of Health), on the sanitary condition of Poplar, states that at Poplar's seven depots the electrolytic fluid was still in great demand by the public, as well as being used as hitherto by the Public Health Department for various purposes. The materials used are chloride of magnesium, salt and caustic soda. Manufacturers can obtain the fluid through the Electricity Department.

Another "Live Wire" Accident.—Scarcely a month passes in the South Wales district without a record of a fatality or serious accident through persons coming into contact with a "live wire." A married man, named George Clements, of Llanelly, has been admitted into the General Hospital suffering from a fractured skull. He was engaged at Llanelly Copper Works in connection with a crane, and came into contact with the electric wire and fell from a height of 15 feet.

Denmark.—A meeting is to be held in Christiania, on the 19th and 20th, August between representatives from Norway, Sweden and Denmark to discuss proposals for the transmission of electrical power from Norway to Denmark. Two alternative lines of transmission have been mentioned, namely, via Goteborg across the Cattegat to Fredrikshavn and from the South of Norway to Hirtshals. The Commercial Secretary to H.M. Legation at Copenhagen is, however, of the opinion that the present economic situation in Denmark will prevent any schemes of this nature materialising for some time.

Plant Required.—The Pretoria E.L. & P. Dept. requires tenders by October 4. for 6,600 volt cable, coal handling plant, induced draught and ash handling plant, feed pumps, piping, etc. Particulars from Mr. T. C. Wolley Dod, Gen. Manager of the Dept., or from Mr. G. M. Clark, 40-42, Meischke's Buildings, Johannesburg. Specifications, etc., from T.C., Pretoria, on deposit of £5 5s. for each of the four contracts.——Uruguay Board of State Electrical Stations requires four 4-stroke Diesels, two D.C., and two A.C. generators. Tenders by 19th September. Particulars from D.O.T. (Room 49).

Marconi Wireless Patents.—A verdict in favour of Marconi's W.T. Coy., Ltd, and the Compania Nacional de Telegrafia Sin Hilos has been given in the Spanish Courts as the result of a joint action brought by these companies against the Compania Iberica de Telecomunicacion for infringement of patents relating to thermionic valves. The award nullifies certain "Telecomunicacion" patents known as the "Deforest Audion"; requires the defendants to hand over to the plaintiffs all materials manufactured under the patents concerned, and orders the payment by the Telecomunicacion Company of an indemnity to be fixed.

B.E.S.A.—At the Annual General Meeting the Chairman stated that there are now over 1,500 engineers giving their time and experience to the important work of standardisation. The business community did not, however, support the Association as it should. Last year £15,000 was expended. Industry contributed £10,000 and the remainder took the form of grants from the Treasury and the Indian and Dominion Governments. Questions to be considered are the advisability of giving greater publicity to the work of the Association, and the assisting of purchasers to ascertain without difficulty the names of manufacturers prepared to work to British Standards.

Hydro-Electric Works Abroad.—Japan is engaged in developing 100,000 kw. for various purposes from the waters of the Dakyui River and Lake Candidus (Formosa). Some heavy constructional work is involved. A further 7,500 kw. is being developed by the Formosa E.P. Co. in the Giran district of the Taihoku Province on the east coast.——Some hydro-electric plants are in operation in Finland, and the Govt. has in hand the further development of the large available water power, including 150,000 h.p. from the Imatra rapids.——In France, besides the Rhone projects, several other large hydro-electric developments in the Vosges, Jura and Pyrenees mountains are under consideration.

Accrington.—The Electricity Committee have had several applications for the supply of current in considerable quantities. In one instance the laying of a H.T cable was necessary, but as the cost exceeded £2,000 the Committee could not sanction the proposal. Messrs. Steiner & Co., of Church Docks, desired a night load of 900,000 units per year. A cable was necessary, and the engineer was instructed to interview the firm thereon. The Phœnix Chemical Co. asked for special terms for a continuous night and day supply. Subject to their taking 150,000 units per month for 12 months with an equal load night and day, the Committee agreed to supply at 1.75d. per unit. Messrs. Howard & Bullough, in agreeing to take a minimum of 15,000 units per month, were also quoted a special price.

Outing.—The employees of the Hart Accumulator Co., Ltd., Electric Accumulator Manufacturers of Stratford, London, held their 24th Annual Outing on Saturday, 23rd July, the trip on this occasion taking the form of a visit to Southend by motor chars-a-bancs. After dinner at the Maisonette Café, High Street, the Toast of the Hart Accumulator Co., Ltd., was proposed by the Chairman (Mr. F. J. Holmes, M.I.E.E.), Manager of the Company, who in a few well chosen words explained the difficult times caused by the Trade depression, coal strike, etc., through which the Company had safely passed, and urged upon the employees the necessity of taking their share of hard work to enable conditions to become more normal. Mr. C. Cartwright (Vice-Chairman), proposed the Toast to "The Chairman," which was suitably responded to. After dinner, the time was spent in various ways, according to the personal inclinations of one and all, and the return journey was made at 7.45 p.m., Stratford being reached about 10 p.m. The thanks of all concerned are due to the Committee, who organised such a successful outing, and to Messrs. W. McDonald and C. Cartwright, who acted as Hon. Sec. and Treasurer respectively.



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AUGUST 19, 1921.

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ELECTRIC LOCOMOTIVES FOR INDUSTRIAL PURPOSES.*

The question of the substitution of the electric locomotive for the steam locomotive in industrial work is now receiving the attention the subject deserves. It has long been recognised that the small steam locomotive, for industrial purposes or in shunting yards, is wasteful and inefficient, but in the majority of cases this has been regarded as a necessary evil. The inertia of an established institution is notoriously great and, generally speaking, the introduction of electric traction previously to 1914 was confined to tramways and passenger-carrying railway stock, while the electric locomotive for industrial work had only obtained slight recognition. It is impossible to estimate what might have happened between 1914 and 1920 had normal conditions existed, but there is no doubt that the economic position has greatly changed during that period, and the question must now be studied from a different point of view.

The cost of production has greatly increased, and two of the main factors which have caused this are dear coal and high wages. Because of the high cost of coal and labour, any saving which can be effected in the use of either or both must reflect very markedly on the cost of production. When labour and coal were cheap, a certain amount of waste was not relatively important, but this is not the case to-day.

In most works one source of waste is in the handling of material with steam locomotives. Consider the proportion of time spent in doing useful work to the total time during which the steam locomotive is burning fuel and using water. Before going into service, steam has to be raised, necessitating the attendance of a fireman; then bunkers have to be filled and water has to be taken on board. During service, when not usefully occupied, the consumption of fuel and water still goes on, and in the majority of works these stand-by losses must necessarily be considerable. After service the fires have to be drawn and the ashes cleared away.

In addition to this daily waste, the steam locomotive must be withdrawn from service at intervals for boiler washing, repairs to fire-box, repairs to glands and numerous other small fittings. At long periods the steam locomotive must have its boiler thoroughly cleaned and re-tubed. During the time these repairs and renewals are being effected, besides the labour and inconvenience entailed, the locomotive represents capital laid idle.

As an alternative, it is claimed that an electric locomotive eliminates a great deal of this waste. It is ready for use when required. There are no stand-by losses. At the end of the day it can be put in the shed and left. The drive is through rotational machinery, and, consequently, the torque is even, which means that the driving parts do not have to withstand the impulsive forces to which the steam locomotive is subjected. Repairs are infrequent and quickly effected.

A steam locomotive must be engined for the heaviest load to be hauled, but this is not the case with an electric locomotive. The latter can be motored for the normal load, as it is capable of sustaining heavy overloads for short periods.

In addition to the above points, the electric locomotive scores because it is clean, needs the minimum amount of labour for driving, and is less likely to cause fires. There is always danger of fire with a steam locomotive, due to sparks and red-hot cinders, and it is a fact that insurance companies are willing to accept smaller premiums when electric locomotives are substituted for steam locomotives.

The works in which locomotives are used may be divided broadly into two kinds:—

(1) Those which require intermittent service.

(2) Those which require continuous service.

In the first class there are power stations, gas works, and small factories where the large railways deliver and collect material three or four times a day.

In the second class there are colliery yards, steel works, and large works generally.

In addition to these, there are others where special conditions exist, such as wood yards, docks, paper mills, etc., where cleanliness and the prevention of fire is of great importance.

For the first class a battery locomotive may be used, while, generally speaking, a trolley locomotive is recommended for the second class. There may, however, be objections to the installation of overhead wires, and then the battery locomotive must be used.

Sometimes a combination of the two is advisable, as in the case of the ordinary steel works. A steel works usually has a fairly level track alongside the furnaces and a heavy grade up to a slag tip; near the furnaces, overhead wires are objectionable, but up the grade they can be installed without inconvenience On the level, therefore, it is necessary to use a battery, but up the grade, where a heavy demand would be made on the battery, the locomotive runs on the trolley wire. The use of the trolley wire up the grade enables the battery to be kept within reasonable dimensions, or alternatively, it does not need to be charged at such frequent intervals.

As a guide to the relative costs of steam and electric locomotives on a basis of work done, the following figures have been compiled, and although it is not claimed that they will apply in all cases, there is no doubt that they are representative and do not unduly favour the electric locomotive. The figures for repairs and maintenance, depreciation and interest on capital include all charges attendant on each system. For steam locomotives account has been taken of coaling, watering and repair plant, and for electric locomotives, overhead line, battery charging, converting and repair plant have been allowed for.

In the following table 100 has been taken as a basis figure for each item:—

	Steam.	Trolley.	Battery.
Repairs and maintenance	100	33	50
Power	100	33	40
Lubrication and miscellaneous	100	33	53
Wages	100	50	50
Depreciation	100	60	90
Interest on capital	80	100	100

The overall operating costs of the three systems are in the following proportion:—

Steam 100, Electric Battery 60, Electric Trolley 50.

The only item in which steam traction compares favourably with electric traction is in capital cost, but the total annual saving in operating costs is such that even with a small system this extra cost is wiped out in less than two years.

*English Electric Journal.

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The figures given above are for small systems where only one locomotive is used. On larger systems, however, greater economy would be effected by the use of electric traction, as a number of steam locomotives can be displaced by a smaller number of electric locomotives. The proportion varies according to the nature of the service. For intermittent service two electric locomotives would do the same amount of work as three or four steam locomotives. Where the service is continuous, one electric locomotive of the trolley type would be required in place of each two steam locomotives, while, if battery locomotives were employed, one locomotive and one spare battery would be necessary.

The larger the system the greater becomes the ratio of steam to electric locomotives required for the work, and this difference offsets the higher cost of the electric locomotive.

In further consideration of the capital cost, it is important to remember that where, with steam work, a spare locomotive would be required, an electric system requires only a spare armature. Also, electricity is so generally used for power purposes that the majority of works would only incur a small additional cost by installing the necessary plant for supplying current to the line or for charging batteries. In regard to this auxiliary plant, it is well to point out that an increased number of locomotives requires only a small increase, if any, in the overhead and battery charging plant provided. The overall capital cost per electric locomotive is thus reduced where several locomotives are employed, and the total capital cost is little different from that of the requisite number of steam locomotives with their water, coal and repair plant.

Realising the trend of progress, the English Electric Company, as a result of searching inquiry into present-day conditions, has developed a line of locomotives suitable for a wide range of requirements. A number of difficulties had to be contended with, due to the fact that conditions are very variable. Track gauges vary from 18 in. to 5 ft. 6 in.; the voltages of available supplies differ; stock to be hauled and numerous other details are met with in infinite variety; all of these have influence on the design of the locomotive. Nevertheless, it is believed that the types developed will meet almost all industrial requirements. These locomotives range in weight from about 4 tons to 22 tons on two axles, heavier and larger locomotives being classed under a different category.

Examples of these standard locomotives recently constructed are given below.

Type 1A locomotive is the smallest of the three types developed. It can be arranged to suit all gauges from 1 ft. 6 in. to 2 ft. 6 in., and has been specially designed for work in confined spaces. On the minimum gauge the overall width is 2 ft. 10 in., and the minimum height over the cab roof is 3 ft. 6 in. It is fitted with 16 in. wheels and has a 3 ft. wheel base, so that it can negotiate curves of 14 ft. radius. The frame is built up of steel plate, braced with stretcher plates and angle iron, to which the cast steel horn guides are attached. The weight of the frame is taken on the axle boxes by helical springs. The cab affords head protection to the driver and is open at the sides. The screw-down hand brake operates brake blocks on the inside of each wheel.

The electric equipment consists of two 11 h.p. motors, each driving on to its axle through worm gearing, and a series parallel controller with seven power notches and five rheostatic braking notches. The normal speed is five to six miles per hour, and the maximum tractive effort is 2,000 lb. at the tread of the wheels. A circuit breaker and an ammeter are fitted inside the cab, whilst the resistances of standard grid pattern are carried inside the framing at the rear end of the locomotive. A voltmeter, ammeter, and ampere-hour meter are supplied with locomotives of the battery type.

The weight of the locomotive, complete with electrical equipment and battery or ballast, is 3½ tons.

When the locomotive is to operate from a battery, this is contained in a removable ventilated compartment, which is fitted with wheels so that it can be run off the top of the locomotive on to a charging table. It is a matter of a few moments only to disconnect the battery and replace it with a spare battery when the used one needs recharging.

(To be continued.)

HARWICH-ZEEBRUGGE ROUTE TO THE CONTINENT.

The new short sea route to the Continent via Harwich-Zeebrugge, recently inaugurated by the Great Eastern Railway Co., adds yet another to the well-known routes via Harwich, and should prove invaluable to business men, as well as to those desirous of taking a short holiday abroad. Further, it is bound to act as a stimulus to trade. The service is thrice weekly in each direction—Monday, Wednesday and Saturday outwards, and Tuesday, Thursday and Sunday inwards. Leaving London (Liverpool Street) at 8.40 p.m., Zeebrugge is reached in time to catch the 6.10 a.m. connecting train for Bruges, Brussels and beyond; and in the reverse direction, leaving Zeebrugge at 11.30 p.m., London is reached at 8.0 a.m. The arrangement permits of leaving London on Saturday night, spending a full day ashore, and being back in London on Monday morning, sleeping aboard, and thereby being relieved of luggage worries and an hotel bill. Cheap week-end tickets are issued for this week-end "excursion." Similarly, 18 clear hours can be spent ashore by anyone having only a single weekday to spare. Through restaurant car expresses are run on weekdays between Liverpool, Manchester, Sheffield, etc., with connections from the principal industrial towns, to Harwich.

An illustrated booklet, giving full particulars, will be sent on application to the Publicity Dept., G.E.Rly., Liverpool Street Station, E.C.2.

POWER FOR TEXTILE MILLS.

The general application of electricity to the cotton manufacturing process has formed the subject of many interesting discussions. Even now there is divided opinion on the question.

Mr. Arthur Charles, managing director of Components, Ltd., of Burnley, told a Burnley gathering last week that electrical plant, correctly installed, was probably safer than any other power factor, and it was as economical. He pointed out that in 1910, 998 consumers in Burnley paid for 3,249,287 units, as compared with 3,000 consumers and 7,594,107 units last year.

Councillor L. Thornber, a prominent cotton manufacturer, said the application of electricity to textiles was all a question of cost. So far as he could gather, current for mill power could not be supplied cheaper than steam could be produced. Electricity would have to be produced under ½d. per unit to be profitable to run a cotton mill, though he was prepared to admit that electricity would ensure a better and steadier drive. He recently attended a textile conference at Basle, and was surprised to learn there were 6,000 generating stations in Switzerland, 5,200 of which were of less than 500 h.p. The highest charge was ½d. per unit. The railways and industrial concerns were being electrified. In the Bombay district the river had been dammed, and current was being produced at less than ½d. per unit, sufficient to drive all the cotton mills in the area. No more steam engines were being sent to this part.

Mr. J. Holden, chairman of the Electricity Committee, stated that current was produced in Burnley cheaper than most places in the country. In fact, there were only eight towns in England where it was produced cheaper.

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SMALL TRANSFORMERS FOR SPECIAL PURPOSES.

Small transformers for bell-ringing and the operation of electric toys and models are now being supplied by The British Thomson-Houston Co., Ltd. Where the supply is A.C. the bell batteries may be done away with and a transformer installed.

The B.T.-H. bell transformer is supplied for 100-110 and 200-220 volt circuits; the former having a frequency range of from 25 to 140 cycles and the latter from 50 to 140. The core and coils are encased and sealed in a neat black enamelled case, which effectually prevents unauthorised interference.

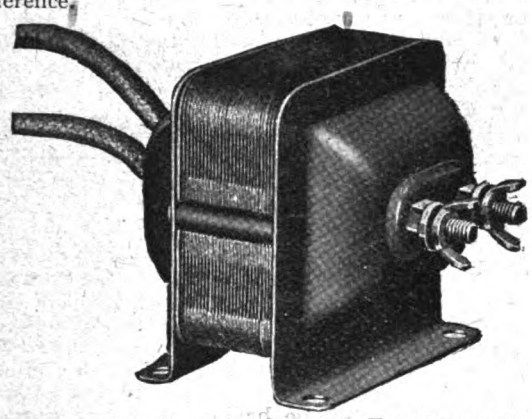


FIG. 1.—B.T.-H. BELL RINGING TRANSFORMER.
Approximately three-quarters full size.

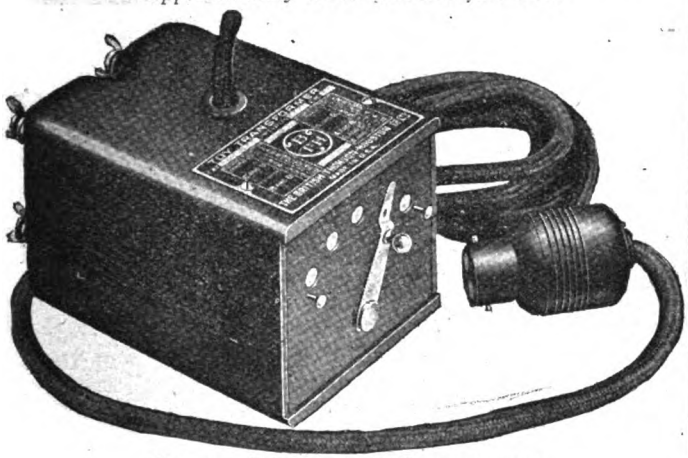


FIG. 2.—B.T. H. TOY TRANSFORMER.
Approximately one-third full size.

The B.T.-H. toy transformer possesses fascinating possibilities for the modern boy, as it gives a safe and constant supply of electricity for the operation of any electrical toy or model. Six feet of flexible cord and a lampholder adapter are supplied.

B.T.-H. toy transformers are made in four patterns, all of which, with the exception of the smallest, are provided with control switches on the secondary windings and alternative primary tappings. These two adjustments permit of a wide variation of secondary voltages, ranging, in 2 volt steps, from 4 to 22 or 28 volts. The smallest of the four toy transformers is finished in green, and may be used for working small motors, etc. The middle two are finished in red and black, and are suitable for the operation of medium-sized toys; while the largest (also finished in red and black) is intended for the operation of big toys and models.

At present these transformers are only supplied for 110 volt circuits, three of them having a frequency range of from 25 to 49 cycles. Transformers for 200 volt circuits are, however, in course of design, and will shortly be available.

Readers of this note are invited to write to the B.T.-H. Co., Ltd., of 77, Upper Thames Street, E.C.4, for a copy of the new price list (No. 10957) on small transformers. This list, in addition to giving full information on the bell and toy transformers described above, also deals with the famous All-Nite-Lite Transformer, a device for which an enormous demand has arisen within the last few years.

THE ECONOMIC SITUATION IN SWITZERLAND.

Iron and steel goods may be classed as the third most important group of imports from the United Kingdom before the war, if the value of gold bullion imports, which far surpassed in value iron and steel imports, is neglected. The imports of these goods in 1920 were undoubtedly affected by the untoward conditions of the exchanges which favoured German, French, Belgian, and the former Dual Monarchy exporters. But although British imports last year were handicapped by the state of the exchanges and the high British prices, it should also be mentioned, writes Mr. J. R. Cahill, late Commercial Secretary to H.M. Legation, Berne, in his official report published by H.M. Stationery Office, that there was the constant complaint that no fixed quotations could be obtained from British firms and that no periods of delivery could be guaranteed. There was an exceptionally strong demand for various British steel products required in the Swiss electro-technical industry (e.g., electrical steel sheets for transformers, sheets for turbine blades), which enjoyed and enjoy the greatest prosperity, but requirements could not be met by British makers—in one case in fact only one-fifth part of orders were being supplied. In one or two cases in other Swiss industries the firms which preferred to obtain steel products from England and applied to the English market therefor were eventually obliged to obtain them from Germany. In the last six months, however, it would seem that, principally owing to the exchange, Belgian, German, French, and Czecho-Slovakian exporters have been in a position to undersell considerably most British steel and engineering products which do not happen to be definite British specialities. As regards the latter, Swiss orders are now being fulfilled without difficulty.

With regard to the general popularity of British goods, Mr. Cahill says that British products, iron or steel, yarns, cotton or woollen fabrics, furniture, and numerous other goods, enjoy a very high reputation in Switzerland, and, other things being equal, the Swiss are most desirous of dealing with British firms, whose business habits command their respect. A great deal of irritation has been evoked during the past year by the uncertain principles applied particularly by Germany and German firms. The import prohibition; the exaction of payment of Customs duties in gold; the losses entailed by failure of certain German mortgagors to redeem their liabilities in gold under an expressly accepted gold clause in their covenants; the practice of neutralising the mark depreciation by additions to prices of goods when destined for export to Switzerland; the numerous instances reported where orders firmly accepted at a certain price were cancelled or delivery made conditional on acceptance of altered terms; the losses caused to the Swiss public by speculation in German marks and securities or by their participation in holding companies under German influence; and the harm occasioned to several Swiss industries by the immense German imports; all these causes contribute towards rendering German goods less popular than those of other importing nations. But, as prices, suitability to customers, and terms of credit are bound to decide the sale of most articles, British firms may only reap advantage over competitors by keeping the prices of their products as low as possible, by studying closely Swiss requirements and by according flexible credit arrangements.

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A SIEMENS DISPLAY.

A fine display of fluid and dry cells, as manufactured at Woolwich, was shown on the large stand occupied by Siemens Bros. and Co., Ltd., at the London Fair and Market (Agricultural Hall). Included also was a selection of ebonite sheets, rods, tubes, mouldings and coverings, as manufactured in large quantities by the company.



Further exhibits on this stand included the following goods of Siemens' subsidiary company, English Electric and Siemens Supplies, Ltd. :—"Britannia" electric fires and boiling ring; tea sets, kettles, grillers, percolators, table urns, domestic irons, vacuum cleaners; electric light fittings, table standards and shades; electric bells, and "Zed" electric fuses.

Specimens were shown of the Siemens "Britannia" incandescent electric lamps of the vacuum and gasfilled types, as manufactured at the company's Dalston Works. The illustration herewith shows the interior of the stand.

PRAISE, SURELY!

A correspondent in the *Manchester City News* refers thus to the E.D.A. paragraph *re* "Minimum charge" for electricity supply already referred to in our columns :—

Sir,—Few of us have a good word for officialdom (governmental or municipal), but I do salute the author of the "brochure" on the back of our electricity department's bill for current supplied, explaining why a minimum charge is made. It is a classic. You have in twelve lines a veritable text book on : Commercial acumen, logic, abstract reasoning, abstruse argument, socialism (at its "peak"), justice, brotherhood, and last but not least, a discourse on one of the mysteries of the "fluid"! "Multum in parvo" in very truth!

C. HY. BAGNALL.

The paragraph which has excited our correspondent's admiration was as follows : "Broadly speaking, electricity cannot be stored, and as all consumers (except those on the restricted hour basis, who contract to make no demand at time of 'peak' load on the generating stations in winter) have the right to receive a supply at any moment of the day or night, machinery and mains have to be provided and kept in readiness, thus entailing heavy capital and other fixed costs. Practically for every consumer there is earmarked a portion of the machinery and mains, and the costs above named have on the clearest of economic grounds to be placed on the consumer, no matter whether his or her consumption be much, little, or none. In effect, therefore, the minimum charge is the rent for the right to a very useful service, and full statutory power exists for making the charge."

"LEADAL" WIRES AND CABLES.

A NEW TYPE OF LEAD-COVERED WIRES AND CABLES.

INEXPENSIVE AND DECORATIVE

We have pleasure in bringing to the notice of our readers a new type of wires and cables, which has been developed and placed on the market by Messrs. Driver, Drennan and Cooper, Ltd. (Albion Street, Manchester). The new conductors have broadly the same field of utility as ordinary lead-covered wires and cables, with the exception that they are not intended to be suitable for use underground or submerged in water. They are, however, "moisture-proof" in the accepted sense of the term, and can therefore be used satisfactorily for all ordinary wiring purposes.

The special advantages of the new conductors are (i) that they are of very handsome appearance and can be regarded even as a decorative feature when installed as exposed surface wiring; (ii) they are easily installed, being very flexible yet readily retaining the exact shape to which they are bent; (iii) they are considerably less expensive than regular lead-covered wires and cables.

At present the new conductors are made single-core and flat-twin in 600 megohm and 2,500 megohm grades, both non-Association and Association quality. The following core sizes are available : 1/.044 in., 3/.029 in., 3/.036 in., 7/.029 in., 7/.036 in. Other sizes will no doubt be produced as demanded.

The conductors themselves are of high-conductivity tinned copper covered with one layer of pure rubber, two layers of vulcanised rubber, and taped. Over the taping there is applied a wrapping of sheet lead, making nearly two complete turns round the cable and having a close longitudinal seam. Over the lead sheathing is a spiral armouring of half-round bright aluminium wire. This armouring is completely flexible, yet it affords good mechanical protection and gives an excellent appearance to the conductors.

It will be realised that this construction is all that is required for the great majority of wiring jobs, and the cable is to a high degree moisture proof. We understand that experiments conducted with the cable immersed in water at atmospheric pressure show it to be impossible for water to penetrate through to the cable.

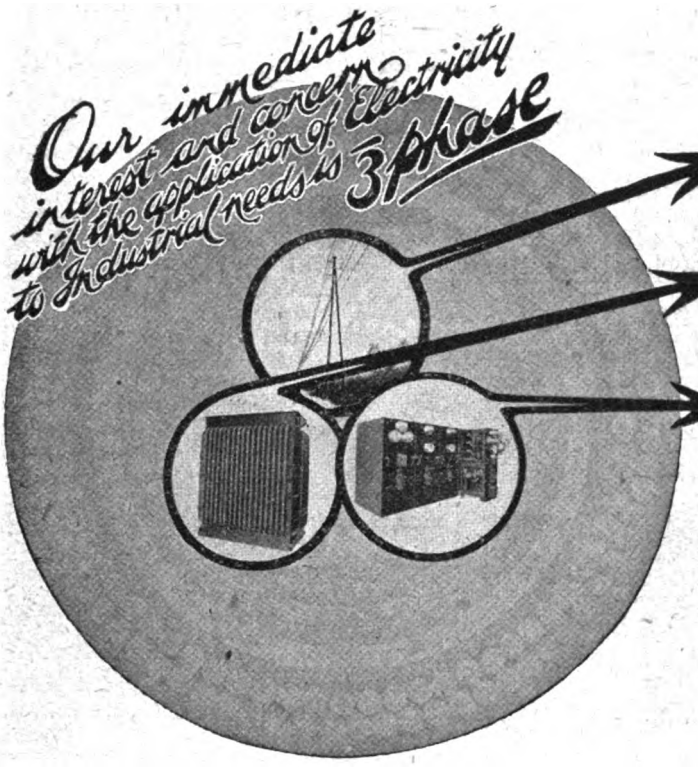
As regards bonding, the makers of "Leadal" wires and cables have decided to adopt White's Universal Bonding System rather than restrict and complicate the application of their product by introducing a special bonding system. White's bonding system meets all general conditions, but it should be understood that other bonding systems can be used with the new wiring system if preferred.

"Leadal" wires and cables appear to offer possibilties of considerable reductions in the cost of wiring which will lead to benefits for all other branches of the electrical industry. Anything which will cheapen electricity supply and service, without sacrificing reliability, is most desirable under present conditions.

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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application.

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Current Topics.

Underground Telephone Cables.

In our issue dated July 15, under the heading "Another Post Office Monopoly," I commented on a case of damage to Post Office telephone cables laid fourteen inches below the footway, in earthenware ducts, and expressed the opinion, which I still hold, that such a practice is calculated to lead to trouble when other workmen are engaged in excavations in the immediate vicinity of the buried cables. Very rightly, and in defence of the Department which he represents, an esteemed correspondent takes up the cudgels and writes me, pointing out that it is accepted engineering practice to lay electric light and power cables at this depth below footwalks. In confirmation, he quotes from *Electric Mains and Distributing Systems*, where, under the heading "Laying of Ducts," Messrs. Dick and Fernie, the authors, give two feet as a sufficient depth for carriage-ways, and less where they are concreted. In footpaths the depth may be much less, and they consider that under flagstones *the pipes containing the cables should be visible as soon as the stones are lifted.* There will then be less risk of accidental injury.

The italics are mine, and this expression of opinion from two such well-known authorities on cable-laying has my full support. Leaving the surface of the conduits visible would prevent most accidental damage, such as that in the case above referred to. Harking back to my critic's reference to standard engineering practice, I am prepared to agree with him that, in laying their ducts at a depth of fourteen inches, the Post Office were fully conforming with accepted practice, but, at the same time, I submit that accepted practice is not always the best practice, and especially so in this case, where what are known as "air-space" cables are concerned. Admittedly it is not a desirable thing to have electric light and power cables subject to accidental damage by a pick or a shovel, but the worst that can happen in such cases is a temporary fault or failure of the insulation, which can be speedily repaired at comparatively small cost and in minimum time owing to the greater robustness of this class of conductor.

Where air-space cables are concerned, the resultant damage is even worse than in the case of a punctured gas main, for the whole insulation of such cables depends primarily upon the invulnerability of the outer lead sheathing, and, secondly, upon the dryness of the enclosed column of air. To puncture such a cable with a pick may conceivably throw a hundred or more circuits out of commission for quite a lengthy period, and, if moisture be present, such damage will frequently entail the withdrawal of a considerable length of expensive multi-core cable and the substitution of an entirely new section, to be subsequently plumbed up to the remainder of the route and duly desiccated to bring its insulation up to the required standard.

It will thus be seen—and, I think, admitted—that the risks in the two cases are scarcely comparable, and that what constitutes good practice in the case of electric light and power cables does not necessarily hold good for telephone cables. I have in past years had considerable practical experience of the difficulties of cable maintenance, and I am firmly of the opinion that air-space telephone cables should either be laid at such a depth that they are remote from casual damage in street-repairing or other excavation work, or, failing this, that the upper surfaces of the ducts should be actually exposed, as advocated by Messrs. Dick and Fernie, so that they advertise their presence on the removal of the flagstones which cover them.

Dealing with my correspondent's concluding remarks, in which he suggests that my recent comments on Post Office delinquencies are prompted by animus against the Engineering Department, I can only add that I have never attacked individual officers, or even individual sections, of that organisation. Like most other members of the public, I am anxious to see the disabilities of the telegraph and telephone service removed, and the acknowledged ability of the Engineering Section of the Post Office given an opportunity to show what it can do untrammelled by the limitations of red tape. I have always contended that the real fault lies with the organisation—perhaps in its unwieldiness and the deference which the technical staff are expected to pay to the purely commercial and secretarial sections. I hope to live to see the day when the engineer-in-chief and his able staff actually direct the development policy of the Post Office, and no longer have to kow-tow to the Treasury—for then, and only then, can we hope for efficiency in the telephone service under State control.

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Peaceful Penetration Once More.

In pre-war days we were wont to admire the enterprise of the German and Austrian youths who were willing to undertake any sort of a job in this country for microscopic salaries, or even to work for nothing, in order to learn our language and gain experience of British business methods. When war broke out, and these 'prentice youths forsook the pen for the rifle, machine-gun and flammenwerfer, to say nothing of the torpedo, expanding bullet, saw-toothed bayonet, and poison gas, we learnt by bitter agonising experience, coupled with the loss or maiming for life of many thousands of our best manhood, the real meaning of this peaceful penetration—to "learn the language."

One would have thought that five years of the worst carnage the world has ever seen would have impressed upon the Hun the fact that his old tricks were recognised, and that it was useless to try them again on the dog he had bitten. Judging by a missive which lies before me, however, bygones are to be bygones, and we are expected to receive our erstwhile enemy on the old terms, and with open arms, what time our war-scarred veterans vainly seek for work at any price. The writer, an Austrian youth of 22, admits that he was in military service at the age of 17. He claims to be capable of conducting business correspondence or interviews, and to be acquainted with customs and transport work. His ultimate aim is to become a world-wide export merchant, and, in order to acquire the necessary grasp of languages and international business experience, is indifferent as to place, country or salary.

He admits to a school knowledge of French, English and Italian, and is careful to disclaim all political motives in his application for a job. He is ready to undertake any kind of work, either mental or manual, in order to "learn the language," and would be "eternally grateful and undertake any obligation with industry and zeal to demonstrate his affection for this country." D——d cheek these people have after all that has just happened. If we were still foolish enough or sufficiently mercenary to take advantage of free services in exchange for business experience, they would again be invading this country in hordes and piling up their combined experiences against "Der Tag." All I can say is that any British firm foolish enough, or sufficiently greedy of its profits, to engage Germans or Austrians at next to no salary, and to the detriment of our ex-Service men, should be compulsorily wound up and prevented from trading in future. The above communication was addressed to a very well-known manufacturing concern in the North, who very properly ignored it, and gave me the facts for publication as a warning to others who may be similarly approached.

More Kilowatts.

As in the manufacturing field, the crying need of the day is greater output of electrical energy, which means increased plants and rapid linking-up of existing generating facilities. We shall never revert to our original industrial supremacy unless we have plenty of "juice" for all normal requirements, with a percentage over for emergencies and to meet future development. Just now the trade in electricity consuming devices, motors, radiators, electrically-driven appliances for the household, and the like, is simply stagnant, because there is not sufficient electricity being generated to meet immediate requirements, although those responsible for the advancement of the country's plans in this connection are wasting weeks in debate and much hot air on arguments and controversies, political and otherwise, which lead nowhere.

Plenty of current at a moderate price per unit is undoubtedly the most urgent need of the country to-day, and of other countries at well, if the reports of my American contemporaries are to be believed. A typical propaganda advertisement inserted in a Chicago electrical journal by one of the leading electrical manufacturing concerns in the U.S. lends emphasis to my remarks. Headed "Is the Oil Lamp Coming Back?" the text of the notice puts forward the startling suggestion that in two or three years time we may again have to revert to oil or candles, simply because there is not sufficient electricity being generated for present and developing needs. For lack of money the electricity supply companies cannot construct service lines to thousands of applicants. In the States at the present time there is a national shortage of no less than 3,700,000 e.h.p., needed to supply the demand in homes and factories.

Much less are the supply companies in a position to serve the million or more dwellings which housing experts tell us must be built within the next few years. "Why haven't they money enough?" is a question we have a right to ask. Well, during a time when expenses for coal, equipment and wages advanced several hundred per cent., the rate per unit for electricity went up less than twenty per cent., taking an average throughout the States. The rates charged for service to-day, states the president of one electric light company, do not produce earnings sufficient to attract the additional capital which must be raised to meet the demands of the present and future.

In this country the tale is very similar, except that we are also handicapped by the apathy of municipalities on the one hand and by the petty bickerings of vested interests, on the other. The subject and its vital influence on our industrial future was well ventilated by Mr. Richardson at the recent I.M.E.A. conference. The Electricity Commissioners, backed by Government, need to ginger up the responsible authorities and take what steps are necessary to squash the worst obstructionists to a national scheme of electrical development, for more electricity we must have, and that immediately, as soon as the necessary additional plant can be manufactured and installed.

ELEKTRON.



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TELEGRAPHY.—GRADE I. (1921).

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy, held in April, 1921.

Q. 1.—Describe the construction and chemical action of any type of primary cell used on telegraph circuits. What are the advantages of the type described?

A.—The primary battery which is most extensively employed by the British Post Office for telegraphy is a modification of the ordinary porous pot type of Leclanché cell. The following is a description of the No. O size, which is used for important telegraph systems such as high speed, quadruplex and long duplex:—

A cylindrical carbon rod, which forms the negative element, is placed in an unglazed porous pot, which is filled with finely powdered manganese dioxide ($Mn\ O_2$) and carbon. The porous pot is placed in an earthenware jar, and two tapered zinc rods are hung in the jar on opposite sides of the porous pot. The zinc rods form the positive element. The earthenware jar is filled to two-thirds of its height with a solution of ammonium chloride ($NH_4\ Cl$). The carbon rod is fitted with a lead top to ensure good contact, and a brass binding screw is fixed in the lead. A strand of thin wires is cast in the top of the zinc rods. The top of the porous pot, of the earthenware jar, and of the carbon and zinc rods are heavily coated with a special paint to prevent the creeping of salts.

When the poles of the cell are joined by a wire, the chlorine in the outer compartment attacks the zinc, forming zinc chloride ($Zn\ Cl_2$), and the ammonium combines with the oxygen of the water, liberating hydrogen. The hydrogen passes through the porous pot to the carbon rod in the inner compartment, where it combines with the oxygen of the manganese dioxide, forming water and reducing the latter to sesquioxide of manganese ($Mn_2\ O_3$). The latter eventually combines with oxygen from the atmosphere and is reconverted into the dioxide.

The cell has an e.m.f. of about 1.5 volts and its resistance is less than an ohm.

From the above description it will be seen that the cell differs from the ordinary form of Leclanché cell in that a cylindrical carbon rod replaces the carbon element of rectangular form, two tapered zinc rods replace the zinc plate, and that finely powdered manganese dioxide is used as the depolariser instead of coarse grained manganese dioxide. The former is much more efficient as a depolarising agent, and its use results in the speedier oxidation of the free hydrogen, thereby reducing polarisation to a minimum. These modifications result in a greatly increased output, and therefore reduce the cost per ampere-hour; the cell has greater constancy, and the cost of maintenance is consequently less.

In some circumstances, manganese chloride solution is used as the excitant in place of the sal-ammoniac. With the latter, the chemical action on the zinc, when the cell is working, results in the evolution of ammonia gas, which has an injurious effect on metals and on secondary cells which may be in the near neighbourhood. No free gases appear to be given off when manganese chloride is used, so that the cell may be sealed and the evaporation of the solution thereby retarded; as a consequence the cell requires less attention when working. Moreover the use of manganese chloride gives a slightly higher e.m.f.

Q. 2.—How are resistance coils wound, and why? What kind of wire is used and what are its advantages over other kinds of wire? What difference would you make in the wires used for a 1-ohm coil and a 10,000-ohm coil respectively, and why?

A.—The method of winding resistance coils is shown in Fig. 1.

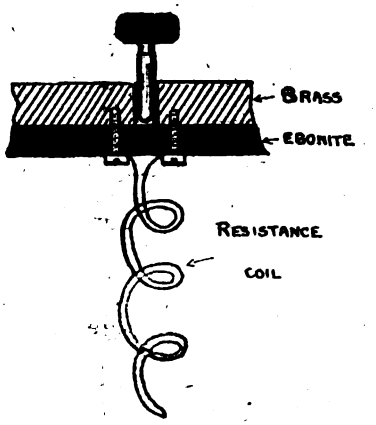


FIG. 1.

The length of wire necessary for any coil of given resistance having been ascertained, the piece is doubled in the middle and wound on a non-magnetic (usually brass) bobbin. By adopting this method of double winding, the magnetic effect due to the current traversing the coil in one direction is neutralised by the effect of the same current flowing in the reverse direction. In this manner self-induction is reduced to a minimum and the movements of magnets in the vicinity will not produce induced currents. The ends of the coils are brought to small brass terminals, which pass through a slab of ebonite, and are screwed into separate brass blocks. The wire is insulated with two or more wrappings of silk, and its gauge varies with the resistance of the coil.

The wire for winding resistance coils should be of high resistivity; it should not oxidize; and its resistance should not vary with change of temperature. The alloys which most nearly fulfil these conditions are manganin, eureka, platinoid, platinum silver, and German silver. The latter is the most extensively used on account of its cheapness. Platinum silver, although otherwise very suitable, is very expensive and is only used for important resistance standards.

The essential difference between the wires used for a 1-ohm coil and a 10,000-ohm coil is in respect of their gauge. For low resistances thick wire is used and for high resistances thin wire. The use of thick wire for high resistance coils is prohibitive on account of the great length and bulk of wire that would be required; this objection does not hold with low resistance coils, which, whatever the gauge of the wire, require a comparatively short length. With thick wire the length required is greater than with thin, and for low resistances allows a considerably more accurate adjustment

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of resistance to be effected than if a shorter length of thin wire were used.

Q. 3.—What are the relative advantages of overhead and underground telegraph lines? Describe the construction of an underground telegraph cable.

A.—The principle advantage possessed by underground lines over aerial lines is immunity from interruptions. Aerial lines may be broken down by gales, by snow or ice, or by accidental or wilful damage. Further, wet weather may materially impair the insulation of aerial lines. From these troubles, underground lines are almost free. Trouble in underground lines may, however, arise from subsidence of the ground, from electrolytic action due to currents leaking from power or lighting mains, or from damage caused to the cable during road repairs; but such troubles rarely occur. Underground cables are less accessible than overhead lines and consequently the difficulty in removing faults is enormously increased.

Underground lines possess the great disadvantage that the electrostatic capacity is greater than in the case of aerial lines, and greater difficulty is experienced in testing and effecting repairs. Moreover in the case of small cables the cost per circuit is greater.

The following is a brief description of a multiple-twin cable:—

The conductors are of soft copper of 100 per cent. conductivity according to the standard of the Engineering Standards Committee. Around the conductor is loosely wound strong manilla paper, either longitudinally or spirally; if the former, the paper is kept in position by a single cotton thread, and if the latter, a definite overlap is allowed according to the size of the conductor. The paper must be uniform in texture and thickness, and free from holes and metallic particles. Two such insulated conductors are twisted together to form a pair; two pairs are twisted together to form a core of four wires; two four-wire cores are twisted together to form a core of eight wires; two eight-wire cores are twisted together to form a core of sixteen wires, or as many eight-wire cores are used to make up the complete cable. To identify the wires of a pair, the paper covering of one is white, and the other is coloured, or the cotton thread may be of different colours. Each pair is given a wrapping of paper of different colours for distinguishing purposes.

The interstices between the eight-wire cores are filled by insulated single wires, or by pairs.

The whole is covered with two wrappings of paper and finally by a seamless lead sheathing.

For long underground routes, cables are made in lengths of ten to the mile, with an allowance for jointing, i.e., in lengths of about 178 yards.

(*To be continued.*)

Trade Notes.

Simplex Conduits Ltd. (Garrison Lane, Birmingham, and 113-7, Charing Cross Road, London) are offering at special prices a number of Plexsim heating and cooking appliances. These include fires from 750 to 2,000 watts loading, kettles, irons, pedestal fires, an electric grill, boiling plate, toaster, footwarmer cigar lighter, and a heating device to facilitate the starting of motor-car engines. Copies of the "Disposal List," which the Co. have just published, will be sent on application.

ELECTRICITY SUPPLY.

REPORT BY THE MINISTER OF TRANSPORT.

The last Report by the Minister of Transport dealing with proceedings under the Electricity (Supply) Acts, 1882 to 1919, covers the period June 27, 1920, to March 31, 1921. In future the annual reports will cover the period April 1 to March 31, and the expenses of the Electricity Commissioners are to be met out of a fund provided by contributions levied upon the electricity supply industry, although temporarily financed by advances from the Exchequer for the first two years. The repayment of advances, with interest, will begin in the financial year beginning April 1, 1922.

Three Special Orders have been submitted to the Minister for confirmation under Section 26 of the 1919 Act. Increase in the maximum price which may be charged has been authorised in some 159 cases. In 11 instances extensions of time for the carrying out of works has been allowed, while in six cases consideration of the question of the revocation of powers has been deferred. Sanction for the use of overhead lines has been accorded in 29 instances.

Among the other matters referred to are the construction of interim works and the proceedings before the Commissioners. Under Section 18 of the 1919 Act, four applications were made to the Minister for the construction by him of generating stations or main transmission lines pending the establishment of joint electricity authorities in certain districts which have been provisionally determined. After consultation with the Commissioners one of the applications was not entertained. In two cases, however, the Minister decided to proceed with the construction of the works subject to certain conditions. In one of these cases the application was subsequently withdrawn, and in the other the interested parties were unable to give the required guarantees, and the application therefore lapsed. The fourth application is under consideration.

In addition to advising the Minister in the exercise of his powers and duties under the Electricity (Supply) Acts, 1882 to 1919, the Commissioners also exercise certain statutory powers and duties vested in them by the 1919 Act, and certain other powers and duties delegated to them by the Ministry under the provisions of Sections 2 and 39 of that Act. With the concurrence of the Minister, the Commissioners have prepared, for separate publication, a Report dealing fully with their proceedings for the information of the electricity supply industry and the public generally. The Report covers the period from the appointment of the Commissioners (January, 1920) to March 31, 1921, and the chief matters dealt with concern the 13 electricity districts provisionally determined to date. Local inquiries have been held with regard to the Lower Severn (adjourned), Mersey and West Lancs, N. Wales and Chester, and London.

CARRIER CURRENT TELEPHONY AND TELEGRAPHY.

(*Continued from page* 440.)

Arrangements for Two-way Transmission.—In many aspects this problem resembles that encountered in adapting a one-way amplifying element to a two-way talking circuit by means of a telephone repeater. The similarity of the two problems consists not only in the fact that the carrier channel and the repeater element are both unilateral, or one-way, arrangements, but also that both involve amplification, and therefore the same possibilities of "singing" are present in the case of the carrier as in the case of the repeater.

As in general it is desirable to be able to connect any telephone trunk or toll line to the section of line equipped for operation by the carrier current method, it is necessary

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to adopt for connecting these lines together a circuit of the type which has been studied for many years by telephone engineers, first, in connection with subscriber sets, and, second, in connection with repeater circuits.

At either terminal of the carrier-frequency line, the sending and receiving branches, instead of terminating in a transmitter and receiver, terminate in what are, in effect, conjugate branches of an alternating-current bridge. If the impedance of the artificial line exactly simulates the impedance of the voice-frequency line looking outward from the carrier terminal, an electromotive force applied between the points *a* and *b* does not cause any current to flow in the branch *c-d* of the carrier current circuit. This represents a condition of zero coupling between the input and output circuits of the carrier system; hence persistent oscillations, i.e., singing, cannot be set up. If, however, the balancing network does not accurately simulate the low-frequency line, either of two types of singing may occur. In the circuit arrangement, if the same frequency is used for transmission in both directions, the type of singing most likely to occur would be local singing at either terminal. This occurs for the reason that in general the amount of energy applied to the two terminals *c* and *d* is largely amplified in the course of passing through the circuit—modulator, filter 1, filter 2, demodulator and amplifier. If the unbalance in the bridge circuit is such that the fraction of this energy which is fed back to the points *c* and *d* is as large as that originally supplied, singing occurs. To avoid this type of singing different carrier frequencies may be chosen for transmission in two directions. If this is done, local singing cannot be set up, for the reason that filter 2 acts as a block to the return of the output current on itself. End to end singing, as distinguished from local singing, may, however, occur provided the over-all transmission loss of the line and the terminal apparatus is made less than zero, and provided that there is sufficient unbalance between the artificial lines and the low-frequency lines at both ends. By "transmission loss of less than zero" is meant that the attenuation of the carrier line is more than compensated for by amplification introduced either at the terminal stations or at intermediate repeater stations. However, the accuracy of line balance necessary to prevent end to end singing with carrier circuits such as we have used is very much less than would be required to prevent local singing if the same frequency were used for transmission in both directions. It is interesting to note that in both of these types of singing the sustained oscillations in different portions of the circuit are of different frequencies. Those in the portions used for transmission at voice frequency have some value lying in the voice frequency range. Those in the portions used for transmission at carrier frequencies differ from the carrier frequency associated with that particular channel by the frequency of the oscillations in the low frequency circuit.

Whereas, with the circuit, local singing is prevented by the use of different carrier frequencies in the two directions, it is possible to prevent this type of singing without resorting to different frequencies, with the attendant reduction in number of channels. In this arrangement the energy from the output of the modulator is prevented from reaching the input of its associated demodulator by placing the two in conjugate relation in an alternating current bridge-circuit, of which the carrier frequency line forms one arm, and a balancing network, designed to simulate the line impedance, the other arm.

Both the arrangements have been successfully employed for two-way carrier current transmission.

Carrier Suppression.—One of the systems which has been developed, particularly for use on long high-grade circuits, involves certain fundamental principles in addition to those already discussed. It will be recalled that, as stated, the proper operation of the demodulator requires that the side-band currents, by which are transmitted the characteristics of the speech, be accompanied by a relatively large amount of unmodulated current of carrier frequency. When this carrier current is transmitted from the modulator, it is evident that only a relatively small part of the line current is actually used in conveying the characteristic variations of the voice current. If, therefore, this carrier current is supplied to the demodulator from a local source instead of over the line from the sending station, the amount of line current which it is necessary to transmit per channel is very materially reduced, for then only the relatively small side bands are transmitted. In the application of this method, means must be provided for eliminating the carrier current at the sending end and for supplying it to the demodulator from a local source at the receiving end.

Elimination of the carrier frequency at the sending end can be accomplished by what is known as a "balanced modulator." In this arrangement two tubes are connected in a manner somewhat similar to the "push-pull" repeater circuit which is described later. The carrier potential is applied through the transformer to the common portion of the input circuit in such a manner that the carrier frequency potentials of the two grids with respect to the filament are at any instant the same. The resultant carrier frequency currents in the plate circuits of the two tubes are then equal, and the fluxes which they set up in the core of the differential transformer are equal and opposite; hence no voltage of the frequency of the unmodulated carrier is induced in the output circuit. By a more detailed analysis it can be shown that the side-band currents resulting from the interaction of the carrier and speech-frequency currents are not balanced out but are reproduced in the output circuit. It should be noted that under these conditions high-frequency current appears in the output circuit only when low-frequency telephone currents are being applied to the input circuit of the modulator.

(*To be continued.*)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 123.

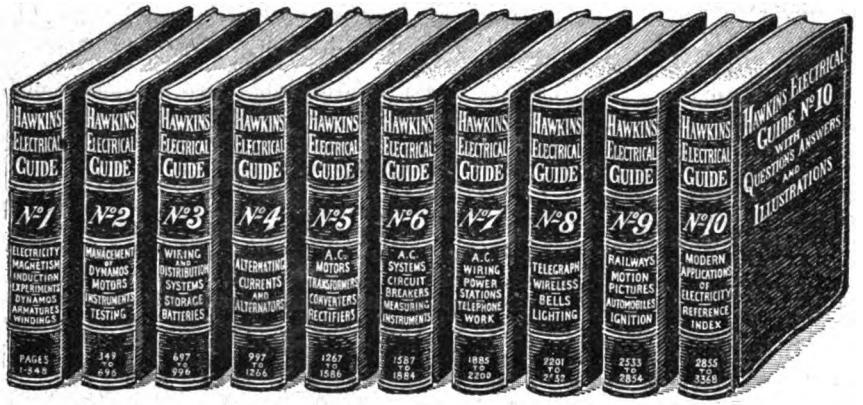
I desire a protective device for tripping a circuit breaker in the 20 to 33 volt generator main of a motor generator which is used for charging a battery of 12 cells. The breaker should trip under the following conditions:—

1. When a reverse current of 15 per cent. of the normal charging current flows through the generator armature.
2. When an overload of 50 per cent. flows for a predetermined period of, say, 10 minutes.
3. When the supply pressure to the motor falls to 50 per cent. or less of the normal supply pressure. The output of the generator is 300 amperes at 20 volts.

(*Replies to Question No. 123 must be received not later than August 27, 1921.*)

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ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to Questions set at the 1921 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

Q. 1.—The speed of a 400 h.p. electrically-driven fan is reduced by (*a*) a shunt motor with field control, (*b*) an induction motor with rotor resistance control. Compare the economy obtainable per hour in the two cases when the speed is reduced 15 per cent. Assume that the torque of the fan varies as the square of the speed and the cost of power is 1d. per Board of Trade unit. Ignore losses in the motors.

*A.*1.—If R = full speed of motors in r.p.m., and T = torque of motors at full load in lb.-feet.

Then h.p. developed $= P = \frac{2\pi TR}{33{,}000}$

Taking the case of the shunt motor,
new speed required $= .85\,R$,
and since torque $\propto$ (speed)^2,
torque at new speed $= T \times (.85)^2 = .723\,T$

$\therefore$ h.p. developed at new speed $= P_1 = \frac{2 \times 3.14 \times .723\,T \times .85\,R}{33{,}000}$

$\therefore \frac{P_1}{P} = .723 \times .85 = .615$

But $P = 400$

$\therefore P_1 = 400 \times .615 = 246$ h.p.

$\therefore$ Reduction in h.p. developed $= 400 - 246 = 154$.

Since losses in motor are to be neglected, reduction in energy supplied per hour to motor
$= 154$ h.p.-hours
$= 154 \times 746$ watt-hours
$= 115$ kw-hours or B.O.T. units.

$\therefore$ Economy per hour in cost of energy
$= 115 \times 1 = 115$ pence
$=$ 9s. 7d.

Next, consider the case of the induction motor. It has to be remembered that so long as an induction motor is exerting a constant torque, the input to the motor remains constant and independent of the speed and therefore of the h.p. developed, the difference between the input to the motor and the mechanical power generated being dissipated as heat in the rotor resistance. We shall therefore consider the change in torque and speed as occurring independently in two steps: first, the speed will be reduced 15 per cent. whilst the torque remains constant; and then the torque will be reduced to .723 of its initial value, the speed remaining constant.

From what has been stated above, it will be evident that after the speed has been reduced 15 per cent. with constant torque, the electrical h.p. taken by the motor still remains at 400 (the internal losses of the motor being neglected). Since the h.p. is proportional to the torque as long as the speed remains constant, the input to the motor after the second step will be reduced to $400 \times .723 = 289.2$ h.p.; i.e., the reduction in the power taken by the motor $= 400 - 289.6 = 110.8$ h.p.
$= 110.8 \times 746$ watts
$= 82.7$ kws.

$\therefore$ Economy per hour in cost of energy
$= 82.7 \times 1 =$ 6s. 10¾d.

From a comparison of the above figures, it is seen that the economy per hour effected with the shunt motor is about 2s. 8d. more than with the induction motor.

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.

"THE JOURNAL OF THE INSTITUTE OF METALS," Volume XXV. 522 pp., 27 plates. Edited by G. Shaw Scott, M.Sc. (1921, London: Institute of Metals. 31s. 6d. net).—As usual, the latest volume of this Journal is a book which should be in the hands of every metallurgist and engineer.

The major portion of the volume is devoted to a number of papers recently read before the Institute, and a verbatim report of the discussions thereon. Amongst the many practical papers contributed, attention may be drawn to one of extreme interest and importance on the subject of "The Season-cracking of Brass and other Copper Alloys." It may be noted that the authors are unable to find in the results of their work any evidence indicating that season-cracking is the result of vicious flow of the inter-crystalline cement, and in this particular their view of season-cracking in brass differs from that of Rosenhain and Archbutt.

Another valuable paper gives an historical survey of the metallurgy of calcium, and describes a type of apparatus developed for its manufacture by the electrolysis of fused calcium chloride. Other notable papers are those on "The Action of Reducing Gases on Heated Copper," "The Constitution of the Alloys of Copper and Tin," a paper on "Stages in the Recrystallization of Aluminium Sheet on Heating," and a note on "The Birth of Crystals in Strained Metals and Alloys." An article of considerable interest in connection with electrical work is that on "The Application of the Scleroscope to the Determination of the Hardness of Thin Brass Strip."

The volume concludes with the usual section devoted to abstracts of papers relating to the non-ferrous and allied industries, which section is more valuable than ever. Reference to the contents of the *Journal* is rendered extremely easy by the full and carefully cross-indexed subject and name indices, and mention should be made of the excellence of the numerous plates and photomicrographs. The Editor is to be complimented upon the exceptionally high standard of excellence maintained by the *Journal*.

LOCKWOOD'S BUILDERS' AND CONTRACTORS' PRICE BOOK, 1921 (Lockwood, 7s. 6d. net).—As usual this excellent work of reference has been brought up to date so far as is possible in view of the constant fluctuations in the cost of labour and materials, and two very useful diagrams have been included, No. 1 showing the rates paid to workmen in August, 1914, at the Armistice in November, 1918, and at the present time, while diagram No. 2 shows the percentage of increase in wages in each case. The section dealing with electrical engineering will be found useful in a general sense to architects and contractors who may have to prepare specifications including work of this nature, and for the rest we have no doubt that the book will sell out just as rapidly as it has in former years. Even though the price is higher than it used to be, it is still wonderful value and can be cordially recommended.

THE ENGINEERS' YEAR BOOK, 1921. By R. H. Kempe. (Lockwood, 30s. net.)—The new edition of this standard annual does not call for much comment. It has been most carefully corrected and brought down to the latest date, together with a summary of engineering progress

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during the past year, and it is now, as it has been for quite a number of years, a veritable encyclopædia of engineering knowledge, the value of which it is hardly possible to express in a brief review. It appeals to engineers in all branches of that great profession, and those who purchase it may rely implicitly upon the information given as being correct. We can recommend it to our readers as being a book which should undoubtedly be in their possession. Our advice is to get it, and without delay.

AMERICAN AIRSHIP'S TRANSATLANTIC VOYAGE.

DIRECTION BY WIRELESS.

In view of the arrangements being made for wireless assistance during the forthcoming flight of the R38 across the Atlantic, it is interesting to recall an outstanding achievement connected with the double voyage of the R34 in 1919. When the British airship was approaching America a message was sent to it from the Air Ministry, through the Marconi Station at Clifden, asking for an immediate reply. This reply was received at the Air Ministry, Hotel Cecil, via Glace Bay (Canada), Clifden (Ireland), and Marconi House, London, within twenty minutes of the dispatch of the original inquiry.

This performance was the subject of a complimentary reference in an official report.

The R38 also is to have the assistance of Clifden Station during her transatlantic flight. The airship is fitted with direction finding apparatus, and will take bearings on Clifden by listening to the signals transmitted by that station in her ordinary service to Canada. In order that there shall be no question as to the identity of the station, Clifden will repeat her call letters (MFT) at intervals of about fifteen minutes. (R.38 has been sold by the British to the U.S. Government.)

Various Items.

Lynn.—The Town Council's Fittings' Dept. is to be discontinued in a month's time.

Worksop.—The U. D. C. have received sanction for the borrowing of £25,000 for electrical extensions.

Beckington (Somerset).—It is proposed to afford the village an electrical supply at 10d. per unit. Edmundson's Electricity Corpn. suggest the utilisation of the old mill on the river for a miniature hydro-electric power-house.

New Zealand.—The P.W.D. has invited tenders for six sets of 3-phase air-break switches for the 50,000 volt circuits in connection with the Waikato Electric Power Scheme Tenders to Sec., P.W.D. Board, Wellington, by Sept. 27. Specification, etc., Inquiry Room, D.O.T.

Bolton.—Whilst on a ladder at Salford Station, Wm. J. Tomkin, of Farnworth, collapsed and was found dead holding on to a ring. He was engaged cleaning a gutter where there were insulated wires. The cause of death was paralysis due to high tension electric current. A verdict to this effect was returned at the inquest.

Great Harwood.—The D. Cl. have approved of Blackburn Corpn. supplying electricity for public and private purposes in the townships of Great Harwood, Clayton-le-Dale, Wilpshire and Ramsgreave, and to sell therein electrical fittings and apparatus. This will involve a revoking of the Great Harwood Electric Lighting Order of 1912.

Australia.—The Victorian Railways Commissioners invite tenders for 3-phase motors, starters, circuit breakers and switches (Contract No. 34181). Tenders, accompanied by a preliminary deposit of one-half per cent of the total amount of the tender, to Melbourne, by October 19. Local representation is essential. Specification, etc., Room 59, D.O.T.

New Company.—Allenwest-Brookhirst (1921), Ltd., has been registered as a private company, with a nominal capital of £550,000 in £1 shares. The objects are to adopt agreements with Allen West and Co., Ltd., Brook, Hirst and Co., Ltd., Electric Control, Ltd., and the Watford Electric and Manufacturing Co., Ltd., and to carry on the business of electrical and mechanical engineers and contractors, manufacturers of and dealers in electrical switchgear, control gear, engines, and apparatus, brass, iron and metal founders, &c.

Copper with Properties of Steel.—According to the *Daily Telegraph* "Despatches from Laporte (Ind.) state that Walter Bunton, an employee of the New York Blower Company, has discovered a method of tempering copper and thereby producing a metal harder than steel. He has sold the secret to the United States Steel Corporation for $1,000,000 and a royalty of 2c. per pound of copper tempered by his process." If this process should not affect the electrical properties, it is not difficult to speculate as to many uses for which the new copper will prove most valuable, provided that its cost is not much above that of the copper at present in use.

Service Notes.—Mr. P. J. Watts, O.B.E., first assistant electrical engineer, who has been at the head of the electrical engineering department at Sheerness yard since July 5, 1917, as electrical engineer (acting), has been promoted to electrical engineer; and in the same department Mr. A. R. Reeves, inspector of electrical fitters, who has been employed on Admiralty overseeing duties in the Birmingham district for some years past, has been appointed second assistant electrical engineer in the place of Mr. A. E. Frankling. The promotion of Mr. Watts is to the vacancy caused by the death of Mr. A. G. Newington. Mr. Reeve's advancement makes a vacancy for an inspector of electrical fitters at the yard.

Newport's Electricity Undertaking.—A net profit of £7,180, notwithstanding a large increase in expenditure, has been made on Newport Borough's electricity undertaking. The reserve fund now stands at £21,377 and the amount of repaid capital is 66 per cent.

Stepney.—The gross profit realised by the Electricity Supply Dept. during the year was £53,349, which is just over 7½ per cent. on the averaged capital expenditure, and nearly 10¾ per cent. on the balance of outstanding loans. After meeting loan interest and repayment, and taking into account sundry smaller items also chargeable against the gross profit, the net profit amounts to £9,376. The cost per unit for coal and wages was 185 per cent. in excess of that for 1913-14.

South Africa.—The Administration of the S.A. Rlys. and Harbours have invited tenders for the supply of (1) 85,560 Incandescent Train Lighting Lamps (tungsten filament) for 24 volts, 8 to 10 c.p. (2) 8,125 Engine Headlight Lamps, 150 watt, 32 volt (Gas-filled 1·2 watt type with concentrated filament). (3) 50,472 Incandescent Lamps (tungsten filament). (4) 5,545 Incandescent Lamps (carbon filament). Delivery is to be made from stocks held by contractors in S.A., as required and ordered by the Administration during the twelve months ending Dec. 31, 1922. Tenders to Sec. of the Tender Board, S.A. Rly. H.Q. Offices, Johannesburg, by Nov. 7. Specification, etc., Enquiry Room, D.O.T.

Belfast.—A start has been made on the reconstruction of the Corporation tramway lines, and it is expected that the work will extend over two years. With commendable patriotism, the Corporation has covenanted with the contractors to employ ex-Service men of at least 12 months' residence in the city in the labouring part of the work, Belfast being most anxious to help the men who helped the Empire in its hour of blackest need. The bill will prove a very stiff one unless a marvellous fall in the price of labour and material occur. Like many other Corporations, Belfast ran the lines to the very limit of public safety for economic reasons, so that the reconstruction will be more extensive than it would otherwise have been in the ordinary course. The system financially is turning the corner, though not exactly paying as well as it might have done.

An Electric Light Scheme Rejected.—The majority of the Llandovery Town Council seem to be suffering from over-cautiousness. Much consideration had been given to a scheme whereby this well-known town could be beneficially lit with electric light. Mr. Morgan Jones, in moving that the Council take the necessary steps, maintained that the scheme would be a profitable one for the Council. Alderman Daniel Jones seconded and urged the necessity of the town making progress, and Mr. M. H. Nichols proposed a direct negative, remarking that the present public lighting of the borough was second to none in South Wales, since the installation of new lamps with incandescent burners. The Government would not grant a loan to the Council unless they could show a stronger reason than was given for the proposed new scheme. W. B. Jackson econded the amendment, which was carried by seven votes to two.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
AUGUST 26, 1921.

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ELECTRICITY IN FACTORIES.

The annual report of the Chief Inspector of Factories and Workshops for the year 1920 is now available, and may be obtained from H.M. Stationery Office at the price of 1s. 6d. The report is as usual an interesting and valuable document, and runs to 12 chapters, each dealing with a special subject, such as Safety, Welfare, Industrial Diseases, Lighting, Use of Electricity, etc. Further, there are 14 tables.

In his opening statement, the Chief Inspector, Mr. R. E. Graves, points out that the Departmental Committee on Lighting of Factories and Workshops, appointed in January, 1913, issued their first report in 1915, when their work was temporarily abandoned owing to the war. They resumed their investigations towards the end of the year, but owing to the urgent need for economy it has since been found necessary to restrict their inquiries. The Committee are assisting in the preparation of a pamphlet on Lighting in Factories and Workshops which should prove very useful to occupiers.

Of the 394 accidents accredited to the use of electricity 25 were fatal. Most of the cases were due to shock on low pressure A.C. systems, and were due to the usual varied causes. Some of the defects in electrical gear noted by the inspectors were as follows:—

High-tension switchboards.—Isolating switches and oil switches in the same compartment without any division; isolating switches and oil switches in separate compartments, but having one door common to both or having two doors but wrongly interlocked, so that when work has to be done on an oil switch the conductors on the live side of the isolating switches remain unprotected; live metal within reach unprotected; potential transformers connected direct to busbars without any isolating switches or the isolating switches placed in the same compartment with the transformers.

Low pressure and medium pressure switchboards.—Working platforms of iron plates and no insulating mats; switchboards for continuous use, day and night and week-ends, without any means of isolating the oil switches from the busbars; small fuses as for instruments placed at back of board close to live conductors; switchboards not in places set apart for the purpose and where persons employed have to pass close to them. D.P. switches having live nuts on cross bar close to handle.

Transforming sub-stations.—On factory premises without being screened off and high-tension conductors exposed; high-tension terminals of transformers exposed within reach; taped up high-tension tail ends of cables not further protected; sub-stations used as store rooms or workshops.

Earthing.—Many cases of non-earthing of metal work, including portable apparatus, e.g., grinders, drills; a number where the earthing was inefficient, the metal framework of buildings or holding down bolts of machinery being relied upon; earth wires of inadequate size and loosely connected without proper clamps.

Distribution fuseboards.—Many of a dangerous type were found on which it is impossible to renew a fuse without risk of touching live metal either of the fuse carriers or of the fixed parts, e.g., busbars, cable lugs, contacts.

Protection of conductors.—Many unprotected switches, terminals of motors, etc., were found, and cables, where liable to damage, unprotected by casings, etc.

Combined switch and fuse boxes.—Many of dangerous design were to be found in use. Although the fuses may be properly connected on the dead side of the switches, the projecting switch blades or other parts are live and liable to be touched by the person handling a fuse.

The report also contains a reference to the number of generating stations which are too small for the output and have the gear hopelessly jumbled. (No doubt most of these will soon disappear under pressure from the Electricity Commissioners.)

Electrical contractors especially should be further interested in the report on lighting, as showing conclusively that there is still a vast field to be attacked by their persuasiveness. The report states that a wider adoption of electric lighting in substitution for gas is reported from all parts, but—"The activity being shown by employers in seeking to improve the artificial lighting of their works makes it necessary that information as to the principles which should guide them in the installation, and as to the best methods of achieving their object, should be available without delay. The most obvious defect in many installations is that of *glare*, chiefly due to the increased use of half-watt lamps which are substituted for the ordinary vacuum electric globe, and used with inadequate shades. The rival claims of general diffused lighting and localised lighting confront the employer. The former is gaining in favour for factory use. Localised lighting is the more expensive owing to the large number of fittings required, which not only necessitate a heavy initial outlay, but cost a considerable sum in upkeep; as the installation throughout must be good in design and workmanship, and kept in good repair in order to be safe. The last few years have witnessed much development in the use of high-power lamps which increase the illumination for the same consumption of electricity, and this has enabled the employer to provide for the general illumination of his workrooms an intensity of light previously restricted to the small area of an individual operator's work. Such general lighting is in practice usually obtained by means of several half-watt lamps distributed over the room at very varying heights with shallow shades, or far too often, without any shade whatever, but where expert advice has been obtained such lights are either provided with deep shades, dark outside and white inside, which protect the eyes from glare and direct the light downwards, or they are used in conjunction with some form of translucent bowl slung beneath the lamp which softens and diffuses the light, the chief part of which is reflected from the ceiling—known as "semi-indirect" lighting. The "indirect" lighting obtained by means of an opaque bowl, which causes the whole of the light to be received by reflection from the ceiling, is more suited to restaurants and places of entertainment than to factories. For processes requiring brilliant light on the field of work, a combination of general and of localised lighting seems to be the most suitable. An excellent example of this was found in the newly-built room of a jewellery firm where the benches for the men setting precious stones were each provided with a separate shaded electric lamp on a moveable bracket, while the room was well lit by half-watt lights, well shaded with dark green shades lined with white."

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MECHANICAL ADVANTAGES OF ELECTRIC LOCOMOTIVES COMPARED WITH STEAM.*

BY SIR V. L. RAVEN, K.B.E., M.Inst.C.E.

In a comparison between steam and electric locomotives there are a number of prominent features in both types that are perhaps best expressed by the terms "for and against" or "advantages and disadvantages."

Admittedly, the practical experience of locomotive engineers in this country has been almost exclusively confined to the steam locomotive, and for that reason it would probably be well to enumerate in the first instance the mechanical limitations and disadvantages which, every engineer will agree, exist in the steam locomotive, and which, it may be argued, are overcome to a very considerable extent by the adoption of the modern and more up-to-date system of electric traction.

The mechanical disadvantages of the steam locomotive may be briefly summarised as follows:—

The locomotive being a complete independent unit, its power cannot be greater than the capacity of its boiler.

To increase the boiler capacity obviously implies increased dimensions and weight, both of which offer grave difficulties in regard to clearances and strengthening of bridge structures.

It is known that on many railways in Britain the limit of weight has been reached, and further development of power is only possible at enormous expense.

The boiler, cylinders, valve-gear, crankshafts and all reciprocating parts are costly to maintain.

Turntables, fuelling plant and water supply appliances must be provided.

The cab is small and open to the weather, involving discomfort to the locomotive crew.

The locomotive radiates heat and uses coal all the time steam is up, that is during many hours when it is doing no work, and either standing by or coasting.

The wear and tear of the locomotive on the track is considerably increased by the impossibility of accurately balancing the reciprocating parts.

The case for the electric locomotive may be set out by the brief statement that it is not hampered by any of the above-mentioned objections. In addition, one might point out that it possesses other important qualifications, such as:—

Simplicity of mechanical construction and operation.

Increased power of acceleration.

Higher scheduled speed due to the possibility of heavy short period overloads, resulting in more frequent service and increased use of existing tracks.

Uniform turning effort resulting in better factor of adhesion at starting and on gradients.

Absence of all reciprocating movement and accurate balance of all rotating parts.

Facilities for driving from either end of a locomotive.

Accessibility of mechanical and electrical parts.

Better accommodation for locomotive crew by reason of increased cab area and by closing in and heating the cab.

Possibility of coupling two or more locomotives together under the control of a single driver.

Two special points may be referred to, namely, the fuel economy made possible by the use of electric locomotives, together with maintenance costs, and the various designs of electric locomotives depending upon the method adopted to transmit power from the motors to the driving axles.

Fuel Economy.—The production of energy in a power station rather than on the locomotive leads to a very substantial economy of fuel. On a steam locomotive fitted with all modern improvements it is not practicable to work at less than about 2½ lb. of best quality coal per b.h.p. hour, and very few engines are capable of doing this for any length of time. Taking into account additional fuel required for lighting up, stand-by losses, periods of uneconomical working and other factors continually met with in practical working, the average consumption is more like 3½ lb. per b.h.p. hour for passenger engines, and 5 lb. for goods engines.

On the other hand, with electric locomotives, whether passenger or goods, and with up-to-date power station and sub-station plant, it is possible to reduce the consumption of fuel to 1¾ lb. per hour, or even less, of low quality coal per b.h.p. produced on the locomotives. In other words, electrification enables the fuel consumption to be reduced to one-half or one-third, the fuel employed being of a quality unsuitable for steam locomotives.

Cost of Maintenance.—Our own experience with regard to the cost of repairs of electric locomotives working between Shildon and Newport shows that this cost is approximately one-third that of maintaining the steam locomotives which worked this traffic previous to 1915.

The difference in America, however, is much greater, as Mr. Armstrong, Chairman of the Electrification Committee of the General Electric Co., gives figures showing the cost of repairs per mile of three American railways varying from 6.3 cents to 14.6 cents, as compared with a cost of 60 cents per mile for a 2-8-8-2 Mallet steam engine, which is the class of engine that would have to be used to haul a similar train to that taken by the electric locomotive, the cost of repairs of which is 14.6 cents, or one-fourth that of the steam engine.

Class of Drive.—The method by which power is transmitted from the motors to the driving axles is generally spoken of as the "drive." There are two general classes:—

(1) In which the motors are built direct on the driving axles, or are connected to them by reduction gearing.

(2) In which the power of the motors is transmitted to the driving axles through connecting and coupling rods.

In each of these two classes there are numerous distinct types depending upon the details of the drive.

CLASS 1.

(*a*) *Motor with Reduction Gear.*—This is the most widely used method of transmitting the torque to the driving wheels.

The motors are totally enclosed, each driving an axle through single reduction gearing, a pinion being mounted on the end or on each end of the armature shaft, and meshed into a corresponding gear wheel mounted on the running wheel axle. The motors are suspended by a cross-suspension bar with bearings and reaction springs. These, with the motor suspension bearings on the axle, provide the motors with four points of suspension.

This particular design, which is the ordinary double bogie articulated type, is widely used for freight traffic, and is the same as that used on the Shildon-Newport Electrification, North-Eastern Railway, and others in the States and on the Continent.

(*b*) *Quill Drive.*—The motors are mounted rigidly between the frames. Each motor is geared to a quill centred in bearings in the motor frame and surrounding the driving axle. The axle and quill are concentric. The quill is connected to the driving wheels by long helical springs which are clamped rigidly at the ends in castings which are bolted, one to the quill flange, and the other to the driving wheel. All springs with clamps are interchangeable, and any spring may be removed without disturbing any part of the running gear.

The arrangement is such that the axle, quill, pair of wheels, and motor can be removed from the locomotive without disturbing the running gear. This drive secures all the advantages of a flexible gear in cushioning the transmission of torque, and lessens the vibration more effectively than the usual flexible gear construction and mounting. This drive is employed on the geared locomotives of the New York, New Haven and Hartford Railway, also the Chicago, Milwaukee and St. Paul.

* Abstract of Paper discussed at the Engineering Conference, 1921 (Inst. of Civil Engineers).

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Advantages of Quill Drive:—

(1) The driving wheels are large.
(2) The centre of gravity of the locomotive is high.
(3) The dead weight on the track is reduced to a minimum, consisting only of the wheels and axles, without the addition of any portion of the motors.

(*c*) *Gearless.*—The motors are of the bi-polar type, the armature being built directly upon the driving axles, and the other parts of the motor being built into the framework of the locomotive structure. This arrangement is such that any armature with its axle and pair of wheels can be removed from the locomotive without disturbing the rest of the motor.

This design is in use on the Chicago, Milwaukee and St. Paul and the New York Central Railways, and is giving every satisfaction.

The advantages claimed for this design are:—

Simplicity of electric motor owing to the absence of motor bearings and gear, etc.

Facility for examination of motor and removal of armature for repairs if required.

The mechanical arrangement of the complete locomotive is said to possess the required flexibility and balance to enable it to run at any speed equally well in either direction without tendency to oscillate or spread the track.

Class 2.

In this class the rotary motion of the motor armatures is transmitted to the axles by cranks on the motor shafts, or on jackshafts driven by the motors and by connecting rods coupling these cranks with crank pins on the driving wheels.

The principal advantage of this method of drive is that the exact position of the motor in relation to the driving wheels is at the disposal of the designer, and he is therefore free from the restrictions imposed upon him by the necessity for getting the motors into the space between the flanges of a pair of wheels as in all locomotives of Class 1, and is therefore enabled to use large motors and place them in the most convenient position in the locomotive.

This method of drive has not been employed at all in this country, except for experimental purposes. In the United States there are a few examples, namely, the locomotives on the New York section of the Pennsylvania Railroad, others of a different design on the Norfolk and Western Railroad, and an experimental locomotive designed by the Pennsylvania Railroad for the electrification of the Altoona grade. The general opinion in the United States seems to be more in favour of designs which come under Class 1.

On the Continent, notably in France, Switzerland, Italy, Germany, Austria and Sweden, the connecting-rod drive in one form or other is almost universal. Up to the present electrification in these countries has been carried out mainly on the single-phase or 3-phase system, and Continental engineers consider that the additional complications caused by the introduction of cranks and coupling rods are more than compensated for by the advantage of having a free hand with the motor design.

A large number of designs have been worked out. Some have proved quite satisfactory, others have given rise to a good deal of trouble. In most cases the trouble has been eliminated by strengthening up special parts such as crank-pins, Scotch yokes, etc., and by introducing a certain amount of flexibility into the connections between the motors and the crankshafts.



"THE AWAKENING OF PETERKIN."

The above is the title of an 8-page booklet produced by the E.D.A., with the intention of interesting "electrical salesmen and saleswomen, and any official or persons whose duties bring them in contact with the public in connection with the service of electricity." The narrative is well calculated to arouse enthusiasm, and, no doubt, in many cases the outlay of 4d. per copy (in lots of 6 and upwards) would be quickly repaid the manager by reason of increased staff zeal.

Reference is made in the narrative to a "banqueting hall" heated by ten 500-watt radiators, and although not affecting the argument, it would, we think, be better to increase the size in the next reprint—500-watt radiators are not usually to be recommended for such work.

A BELL SIGNALLING PROBLEM.

The following solutions have been given in answer to a query in the *Telegraph and Telephone Age* (New York) as to the methods available for bell signalling, with a minimum number of wires, to be effected between three stations, *A*, *B* and *C*, so that *A* could signal *B* and *C*, *B* could signal either *A* or *C*, and *C* could signal *A* and *B*, the signaller not to ring his own bell.

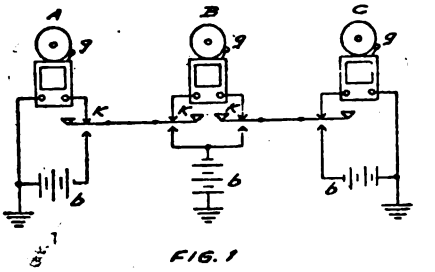


FIG. 1

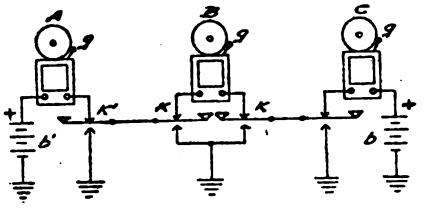


FIG. 2

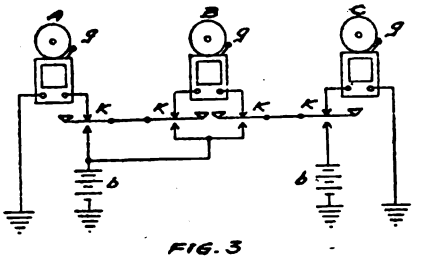


FIG. 3

In the arrangement shown in Fig. 1, a battery *b* is used at each station with earth return; *g*, *g*, *g* are vibrating or single stroke bells; *k*, *k*, *k* are strap keys with upper and lower contacts. In Fig. 2 the batteries are opposed at *A* and *C*, no battery being required at *B*. In this case, normally, no current will flow. When key *k* at *A* is placed to earth it opens battery at *A*, operating the bells at *B* and *C* by means of the battery at *C*. Similarly, when the key at *C* is depressed the bells at *B* and *A* are operated. The operation of the keys at *B* rings either *A* or *C* as desired.

In Fig. 3 a device with a metallic return *A* to *B* is shown. In this arrangement no battery at station *B* is necessary, as will be obvious on examination.

In some cases only one wire is available, in which event the arrangement shown in Fig. 2 is probably the best,

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inasmuch as it does not require a battery at *B*. Besides, in case of an earth on any part of the line circuit, or if either of the batteries weaken, the bells will ring continuously (when vibrating gongs are employed), thereby acting as tell-tales.

Other variations suggested are metallic returns in the arrangements shown in Figs. 1 and 2. If a good earth cannot be obtained at *B*, the earthed key terminal at *A* or *C* may be connected by wire to the lower key terminals at *B*, otherwise arrangement as Fig. 2. So that *B* may know whether signals received come from *A* or *C*, code signals must be used. If it is desired to use only one battery, three wires must be used.

MORE ABOUT FAULTS ON ECONOMISERS.

By H. S. B. ROBINSON.

As the reader will no doubt have gathered from the remarks which have already appeared in a previous issue, faults on economisers are numerous and of a varied nature. Fortunately, however, these may be avoided to a great extent by careful and periodic attention, as may be seen from the following practical suggestions.

Examination.—Although the tubes and boxes of an economiser must be examined internally once each year, and the condition of the lid bolts ascertained, it is of utmost importance that the soot pit should be cleaned out every month, and special care taken to thoroughly clear all spaces between the vertical tubes, bottom boxes, and also inside walls. The tubes, of course, being cleaned out internally when found necessary. The economiser must be blown off for a few minutes daily, both at the top and bottom, by the safety and blow-out valves, the best time for doing this is, obviously, in the morning before starting, or after a meal hour. To shut down economiser, the reserve flue damper must be opened, and the inlet and outlet dampers closed; it will also be necessary to open direct boiler feed valve and close inlet and outlet economiser feed valves. It is important that any dampness in the flues, foundations, or soot pit, should receive attention immediately upon discovery, and the fact that economisers fixed in exposed positions and standing idle must be emptied during frosty weather is no less important. When raising steam, the reserve flue damper should be left open until the engines are started; but after the engines have ceased running, if the feed water is cold, and there are no other means of taking the chill off, it is usual to fill up boilers through economisers by means of an injector. The draught of the boilers is regulated by the main damper at outlet end of economiser and not by the boiler dampers, the latter should only be used in case a boiler is laid off or the economiser is out of operation. The outlet valve between economiser and boilers must not be closed when raising steam or during the night or even at meal times, but it is necessary to feed the boilers constantly and keep the boiler feed valves open, and the feed regulated, as far as possible, by the inlet valve to economiser. Care should most certainly be taken to prevent the admission of cold air into the flues, and any crevices in the brickwork made air-tight; it is also important that the damper in reserve flue should fit tightly. It should be remembered that is is always advisable to use silicate cotton hair, felt or asbestos in preference to composition, which naturally enables the top boxes, lids and lid bolts to be readily examined, otherwise leakages and corrosion may take place undetected. Branch pipe joints should always be accessible for examination, and the gearing and top of economiser protected from the weather by a suitable light roof. All valves, more especially the safety valve, should be carefully examined periodically, and all waste water from valves delivered at a distance from the economiser and not allowed to drain into the soot pit, flues or even cleaning-out space. The tail pipe from blow-out valve should fall evenly to the drain, otherwise the economiser will not be completely emptied. On large economisers, or those working at high pressures, an additional direct loaded spring safety valve may be attached, though it is always advisable to have an escape or relief valve, weighted to lift at a pressure slightly less than the safety valve on the pump or on feed pipe between pump and economiser.

Radiation.—When hot air is used for drying purposes, the heater will be found to work on a similar principle to the economiser, the hot air passing through the tubes receiving heat from waste flue gases in like manner to the boiler feed water. It may, of course, be worked separately or in conjunction with the economiser, in which case the economiser is fixed nearest to the boilers and receives the first impact of the gases. It will be seen, therefore, that the air, which is thus kept at a uniform speed and pressure, leaves the heater through the top air duct at the hot end, or where the gases enter, and passes into use. With an apparatus of this description, the variations in pressure and velocity of the air are reduced to a minimum and uniform increase of temperature is assured. Moreover, the heater being similar in construction to the economiser, it will be found the practical suggestions mentioned above may be applied with like effect. In heating buildings by steam, the amount of boiler and heating pipe depends largely upon the kind of building and its location Wooden buildings require more than stone, and stone more than brick. Iron fronts require even more, and glass in windows demands considerably more heat than the same surface in brick walls. The best place for a radiator in a room is, obviously, beneath a window, as heated air cannot be made to enter a room unless means are provided for permitting an equal amount to escape, exit openings being near the floor. Small pipes are unquestionably more effective than large, and return pipes should be at least ¾ inches in diameter and never less than one half the diameter of the main, longer returns requiring larger pipes. It is most important that, in heating buildings, care should be taken to supply the necessary moisture to keep the air from becoming dry and uncomfortable.

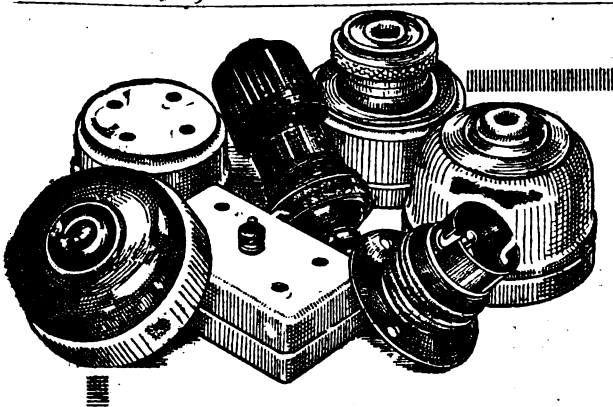
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For the sum of 2s. 6d., users of Edison accumulators in electric vehicles or in stationary situations can now obtain from Edison Accumulators, Ltd. (15, Upper George Street, W.1), a most useful little book on their working and upkeep. Hitherto, so much valuable information has not been available in compact form, but there is now no excuse for not treating the Edison battery properly from the moment it is received from the makers. Briefly put, some of the most important points to bear in mind are always to keep the level of the electrolyte above the tops of the plates, to keep the temperature below 115 deg. F., and to renew the electrolyte when the density falls to 1.160. The cells should be kept clean and dry, and naked lights should not be brought near the cells any more than they should in the case of lead accumulators. Acid must be kept right away, and the battery should be worked through its whole range of discharge occasionally, and should not be charged at much below the normal rate. In exceptionally cold weather, the battery should be warmed with a short boost before a vehicle is taken out, if the battery is not already warm by recent charging.

These and many other matters are treated in a detailed way, aided by illustrations, in the book in question.

Addresses of Commercial Secretaries.—In order to avoid delay it is important that catalogues and communications from U.K. firms to H.M. Commercial Diplomatic Officers, Trade Commissioners, etc., overseas, be carefully addressed. Particulars are given from time to time in the weekly *Board of Trade Journal*

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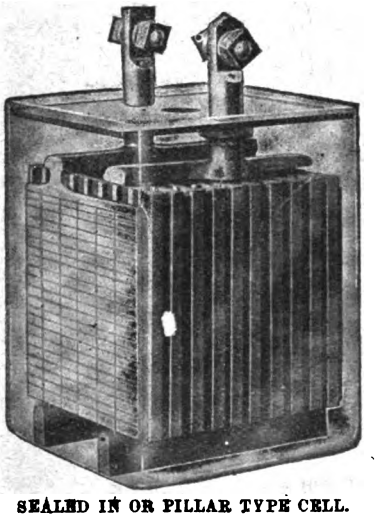
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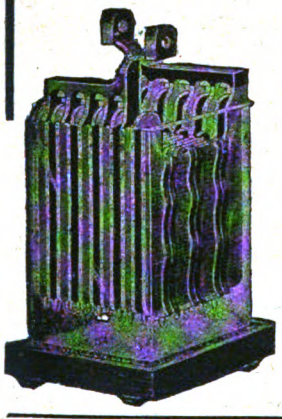
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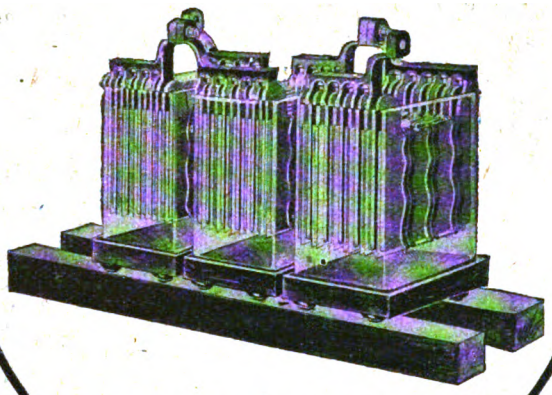
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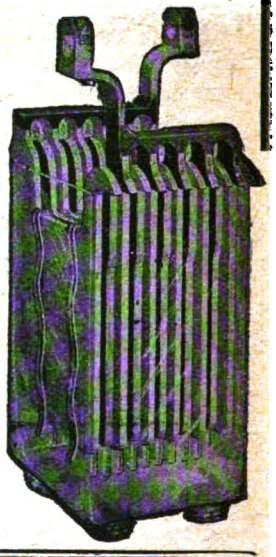
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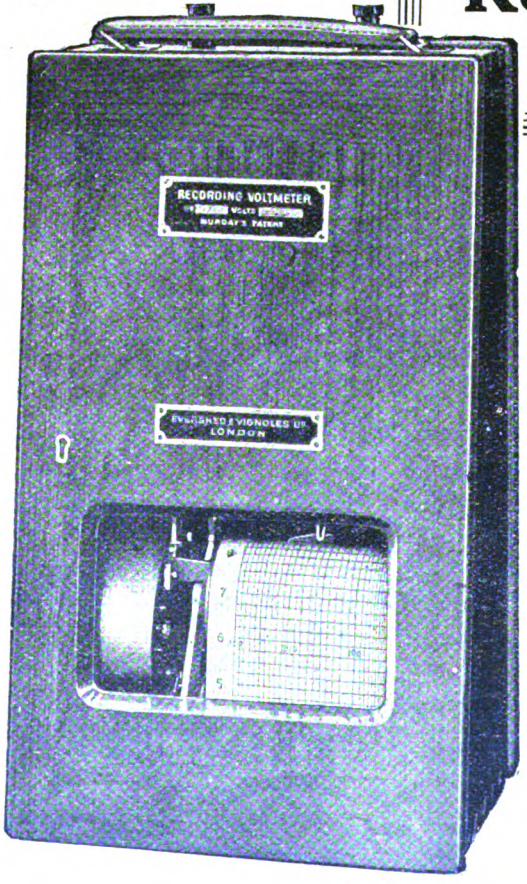
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Questions to which an answer is required must be accompanied by a 6d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 8s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

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Current Topics.

Let the Best Man Rule.

Under the title at the side of this paragraph appeared an excellent article from the pen of Mr. Harold Begbie in the *Sunday Chronicle*, a paper much in favour with the workers in the North. Let us hope that a very large percentage of the industrial population will have carefully read it and taken its contents to heart, for Mr. Begbie preaches the doom of the Bolshevik labour leaders, and advocates their extermination, or at all events elimination, from honest British industry. Now that the strike fever has somewhat abated, it is well for every worker to analyse his past actions or the actions dictated by his union, and strike a balance on the results. I fear that in practically every case the balance will be very much against the worker, for he has lost millions of pounds in wages, millions of hours of useful effort which he will never have the opportunity to again expend during this life, and, as a net result, the trade of the country has been temporarily paralysed.

Mr. Begbie refers to a book—"Social Decay and Regeneration," by Austin Freeman—in which it is explained how the industrial parasite, which is the cause of most present day labour troubles, first came into being. The displacement of the handicraftsman by the machine was his opportunity. Like the parasite that he is, the inferior man was not slow to seize this opportunity. He not only took his place in the ranks of industry, side by side with the superior man, but, multiplying much faster than the superior man, after the manner of all parasites, he gradually swamped the ranks of labour. It is he, the lowest type, who is now setting the pace for the highest. He dictates to the efficient because he is more numerous, and, incidentally, because they are foolish enough to let him. In effect master of the factory, he sets out to become a political dictator also. Against our ancient British principle of freedom and individualism he flings his multitude of unfit, with a cry for base, servile, and ruinous collectivism. The thing he most hates on this earth is real work for a living; the thing he most fears is merit.

So strong and so numerous has the parasite become that the industrial fate of this country is in the hands of the least instructed and the least competent of her population. So far have we progressed from individualism that the thinking of the multitude—thought which involves moral conduct—is done for them, and done for them by the loudest voices in their midst. Take a recent example, fresh in all our minds. The coal strike was commanded, the individual miner did as he was told. When the ruin was complete, when the suffering of women and children had reached its limit, when hundreds of thousands of men in other trades had been plunged into unemployment also, and when millions of pounds had been added to the already crushing burden of national debt, Mr. Frank Hodges turned round to the handful of extremists who had hounded him on and exclaimed, "See what you have done!"

That disastrous and quite mad struggle was possible only because a small group of ignorant and reckless men were able to intimidate the leaders and to use the whole body of the colliers like a soulless machine. The individual collier did not ask himself, "Is this thing right? Is it just? Is it good for *all* of us?" In other words he did not act as a moral and responsible being. Those who knew it was wrong did not dare to say so. The parasites have so arranged an expression of public opinion that the minority of the best is intimidated by the vast majority of the unfit. The collectivist was in the saddle and rode the mining industry down the precipice. The good and intelligent miner was like a sledge hammer in the hands of a monster. Is this worthy of British manhood? Is the British workman no longer capable of managing his own affairs? Is he no longer permitted to think for himself? Has he ceased to be responsible for his actions?

The best way out from this chaos is indicated by Mr. Begbie in the article above referred to. The parasitical spirit must be crushed; individual freedom must recover its voice and its courage; the old test and the old rewards must be restored. The thriftless man who will not work must not be allowed to eat, and the man who works best must be rewarded accordingly. There is an easy step to be taken in this direction. Let each factory, independently of federated trades unionism, elect its own local leaders, and let those leaders be the best workmen and the highest type of man in the factory. There are not ten employers in a hundred who would not willingly enter into cordial consultation with such men.

The existing antagonism which management shows to Labour arises from the insufferable fact that in too many instances Labour elects its worst men to do its talking, and that those men appear before

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managements not only as the advocates for the lazy and stupid but also as the dictators of the trade itself. Mr. Begbie counsels a break with all distant authority, and a straight face-to-face dealing in each separate works, the best man at the top. Is it beyond the powers of Labour to take this step? Let the individual forget that he is a wage-earner, and remember that he is a man. Let him turn his back upon those who have led him so disastrously to the edge of the precipice, and listen within himself for the voice which, earnestly and unselfishly encouraged, can determine all his difficulties. Let him become a living spirit, master of his own circumstances, the slave of no employer, and, what is more important still, the dupe of no imposter.

The Example of Wrexham.

The case of the Wrexham Municipal Electricity undertaking is only one of many similar cases of past sins falling upon the shoulders of the present burgesses. It is the old tale of municipal mismanagement over again, and serves to emphasise the urgent necessity for taking the control of electricity supply out of the hands of a body of men who are only in office so long as the local ratepayers elect to let them stay there, and in any case, know little or nothing of the electricity undertaking they control. Wrexham undertaking is at present suffering from Anno Domini; past Electricity Committees having lacked the foresight to make financial provision for plant replacements following fair wear and tear, to say nothing of evolution in design and resultant economies.

The result to-day is that the Corporation, having ignored the advice of its past electrical engineers, is now saddled with a plant some twenty years old, which is incapable of standing up to the demands made upon it during the winter season unless subject to the unremitting attention of a comparatively large station staff. Old and overloaded plant always requires more care and attention to keep it up to its work than modern gear which has not been subject to years of stress. Now that the committee are faced with this position they cavil at the staff required, and are endeavouring to persuade their engineer to run the station with less men, taking all risk and responsibility. This he very naturally refuses to do, and there has been quite a breeze in the Council over the matter. It is high time the Electricity Commissioners put a spoke in Wrexham's wheel.

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At a meeting of the Privy Council held at Buckingham Palace on Wednesday, August 10, the petition of the Institution for a Royal Charter of Incorporation was approved, and a Royal Charter has now been granted.

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ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to Questions set at the 1921 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page 463.*)

Q. 2.—Two electrical furnaces are supplied with single-phase current at 80 volts from a 3-phase 11,000-volt system by means of two single-phase Scott-connected transformers with similar secondary windings. When the load on one furnace is 500 kw. and on the other 800 kw., what current will flow in each of the three-phase lines (1) at unity power-factor (2) at 0.5 power-factor? Neglect phase displacement in, and efficiency of, the transformers.

A. 2.—Suppose the 500 kw. and 800 kw. furnaces to be connected as shown in Fig. 1; then Fig. 2 gives

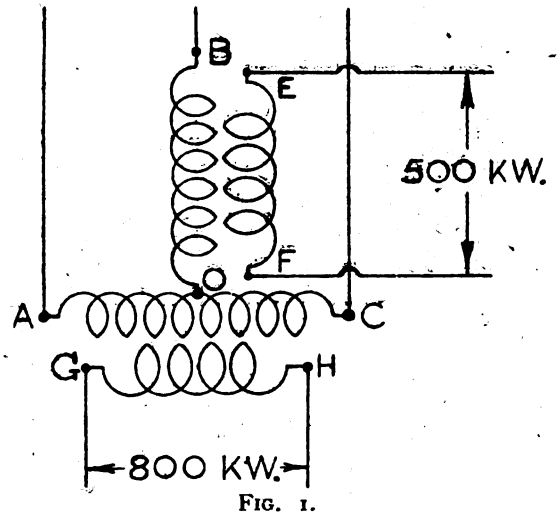


FIG. 1.

the vector diagrams for the voltages on the primary sides, and Fig. 3 the diagram for the voltages in the secondaries. The vectors in Figs. 2 and 3 are drawn to different scales, otherwise the lines in Fig. 3 would be extremely short.

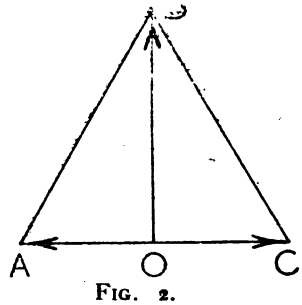


FIG. 2.

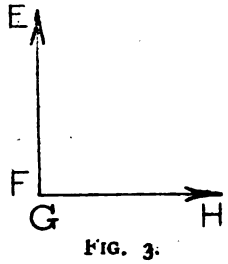


FIG. 3.

Suppose vector OB to represent the voltage in the primary winding OB and to have its positive value when acting from O to B, then vectors OA and OC represent voltages in OA and OC respectively, also having their positive directions when acting outwards from O. The total length AC (Fig. 2) represents the line voltage, so that—

$$OB = OA \tan 60^\circ$$
$$= \frac{AC}{2} \times \sqrt{3} = 0.866\, AC,$$

i.e., voltage across $OB = .866 \times 11{,}000 = 9{,}526$ volts.

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Consider first of all the distribution of current with the 500 kw. furnace *only* in operation. With unity power-factor and 100 per cent. efficiency, the current in OB is $\frac{500 \times 1,000}{9,526} = 52.5$ amps. If the resistance and reactance of the windings be neglected, this current divides at O, half flowing through OA and half through OC; and since they are flowing simultaneously either towards or away from O, their m.m.fs. neutralise each other and therefore have no effect upon the voltage distribution. Further, when the current is flowing in the positive direction in OB, the directions in OA and OC—taken in relation to point O—are negative, so that the vectors for these currents are as indicated in Fig. 4. The magnetising currents, being always very

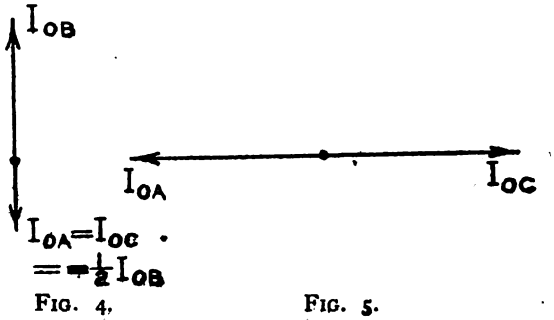


FIG. 4. FIG. 5.

small in comparison with the load currents, have been neglected.

Next consider the distribution of current when only the 800 kw. furnace is in operation. With unity P.F. and 100 per cent. efficiency, the current in AC is $\frac{800 \times 1,000}{11,000} = 72.7$ amps, whilst that in OB is simply its magnetising current which is negligibly small. In relation to point O, the current in OA is equal and opposite to that in OC; i.e., when the current is flowing towards O in OA, it is flowing away from O in OC, but is of exactly the same magnitude. Hence these currents are as represented vectorially in Fig. 5.

When the two furnaces are in operation simultaneously, the resultant currents are obtained by combining Figs. 4 and 5 as shown in Fig. 6, where I_{OA} and I_{OC} represent the resultant currents in the two halves of winding AC.

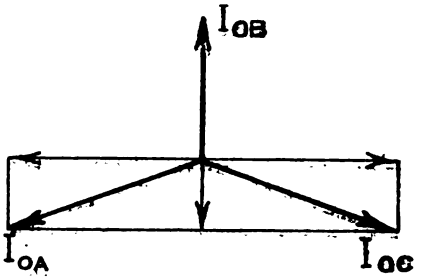


FIG. 6.

Since $(I_{OA})^2 = (72.7)^2 + (26.25)^2$
$= 5980$
$\therefore I_{OA} = I_{OC} = 77.2$ amps.

The current in winding OB is still 52.5 amps.

If the P.F. of each furnace be 0.5 instead of unity, whilst the power remains the same, the currents will still bear the same phase-relationship to one another, and will simply be doubled in magnitude; i.e., the currents in windings OA and OC will be 154.4 amperes, and that in winding OB will be 105 amperes.

If the 500 and 800 k.w. furnaces were interchanged, I_{OB} at unity power-factor would be $\frac{800 \times 1,000}{9,526} = 84$ amps.; and the current in AC (Fig. 1) due to the 500 k.w. furnace alone would be $\frac{500 \times 1,000}{11,000} = 45.55$ amps. The resultant current in OA and OC would be given by—

$(I_{OA})^2 = (45.55)^2 + (42)^2$
$= 3838.8$
$\therefore I_{OA} = I_{OC} = 61.96$
$= 62.$ amps.

With a P.F. of 0.5, these currents would be doubled

(To be continued).

CARRIER CURRENT TELEPHONY AND TELEGRAPHY.

(Continued from page 461.)

Harmonic Generator.—In order to insure that the carrier current applied to the demodulator in this system, employing suppressed carrier, is of exactly the same frequency as that used for modulation at the sending end, an arrangement has been devised whereby both of these frequencies are derived from the same source. For this purpose at one terminal of the system a vacuum-tube oscillator generates a frequency somewhat above the voice range—say 5,000 cycles. Current of this frequency is applied to the input of another vacuum tube in such a way as to overload it. This "harmonic generator," as it has been termed, is so arranged that the current in its output circuit has a distorted wave-form containing prominent components whose frequencies are exact multiples of the applied frequency. The various harmonics of the base frequency (in this case 10,000, 15,000, 20,000 cycles, etc.) are separated by suitably designed selective circuits and led into individual circuits, where they are amplified and made available for use as carrier currents, each in connection with a different channel. At the same time current of the base frequency from the controlling oscillator, in this case 5,000 cycles, is amplified and transmitted over the line to the other terminal. Here it is separated out by a filter, amplified and applied to a second harmonic generator, which produces the same series of carrier frequencies as does the harmonic generator at the controlling station already referred to. These regenerated harmonics may not only be used for demodulating the transmissions received from the controlling terminal, but may also be used in connection with balanced modulators which send in the reverse direction. The demodulators at the controlling station are supplied with carrier current from the harmonic generator at that terminal.

The suppressed carrier system, besides employing smaller line currents, has two other important advantages. One is the absence of audible beat notes resulting from interaction in the demodulating circuits between the carrier frequency normally present and others which may be present through cross-talk or lack of perfect balance. Where all of the carrier frequencies are generated separately, these combination frequencies may in certain cases give rise to disturbing tones within the voice range. With the harmonic arrangement, on the other hand, the only possible frequencies are differences of the base frequency itself and its harmonics, all of which are above the normal voice range, and accordingly are suppressed by the low-pass filter in the output circuit of the demodulator. As a matter of fact, this harmonic arrangement is practically essential where the same frequency range is used for both directions

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The second advantage arises from the fact that variations in the attenuation of the line, due to weather changes or other causes, have less effect on the transmission equivalent of the system where the carrier frequency itself is not transmitted. This will be clear when it is recalled that the magnitude of the voice current in the output of the demodulator is proportional to the product of the amplitudes of the carrier and side band currents. If, therefore, the change in line attenuation is such as to increase or decrease the side band current by a given ratio, the carrier current when transmitted will in general also be changed in the same ratio, and the resulting voice current will be changed by the square of this ratio. In the suppressed carrier system, on the other hand, while the side band is changed as before, the carrier is increased or decreased—not by the change in attenuation which occurs at the carrier frequency, but by the changes, in general much smaller, which occur at the base frequency, so that the voice current is less affected in this case.

Repeaters.—The conditions peculiar to carrier current operation require that the repeaters for this service differ quite considerably from standard voice frequency repeaters. In the first place, on a multiplex carrier current circuit a single repeater installation must handle the energy associated with a number of independent conversations. This could be accomplished by making the installation include a number of repeaters in parallel with suitably associated filter combinations, but it is at once obvious that it is much preferable to install but one repeater channel capable of amplifying all the carrier transmission. The requirements for the repeajter set are made still more severe by the fact that modulation in the repeater tubes, which tends to increase with the load, introduces disturbing factors in carrier operation which are not serious in ordinary repeater operation. The reason for this is that the combination frequencies resulting from the interaction of the currents in two channels may lie in the frequency range of a third, in which case they are transmitted through the selective circuits of that channel and appear as an interfering noise or tone at the subscriber's station. To obtain sufficient energy carrying capacity, and to overcome to some degree this difficulty of intermodulation, we use a number of tubes in parallel in the so-called "push-pull" arrangement.

In this arrangement the input voltage is applied in such a way as to increase the grid voltage of one tube with respect to its filament at the same time that the grid voltages of the other is diminished. The plates are connected with the output circuit by a differential transformer, so that the useful amplified currents from the two tubes are added, while the more troublesome interfering components due to modulation are equal in amplitude and opposite in phase, and hence are balanced out. Instead of employing tubes in parallel to increase the energy capacity of the set, it would have been possible to have used a single tube of larger energy capacity. The scheme of using a number of tubes operating in parallel was adopted in order to avoid increasing the number of types of tubes in the plant.

In repeater operation at voice frequencies, the amount of amplification which can be secured on a given line and with given types of repeater apparatus is limited by the tendency to "sing." The same is true for repeater operation at carrier frequencies. To reduce the tendency of the repeater to sing, the same methods may be adopted as are employed at the terminals; that is to say, if the same frequencies are used for the transmission in both directions, the lines on either side of the repeater must be balanced and the same general type of repeater circuit used as for voice frequency telephone repeaters. If, however, different frequencies are employed for transmission in the two directions, filters may be used to prevent the current sent out in one direction from passing into the input circuit of the repeater set which receives energy from that direction.

While the telephone currents at voice frequencies may be amplified in the same repeater along with the carrier currents, it has been found convenient for reasons of plant flexibility to separate voice frequencies from carrier frequencies by line filters similar to those used at the terminals. Due to the fact that the attenuation of voice-frequencies is much lower than that of carrier-frequencies, it is frequently not necessary to install a voice-frequency repeater at all of the points where carrier frequency repeaters are installed.

Signalling Over Carrier Telephone Circuits.—For a carrier telephone channel to form an integral part of an ordinary telephone connection, it is in general desirable to be able to operate the normal signalling mechanism over the channel without the intervention of an operator at the terminals of the carrier section. This is accomplished by two distinct methods in the two types of systems employed. In the type where carrier current is transmitted over the line an auxiliary rectifier tube is associated with the demodulator in such a manner that the incoming carrier current produces in the output circuit of this rectifier a direct current sufficient to maintain a relay in its operated position. When the operator signals, the ordinary 16-cycle ringing current is received at the carrier terminal. This is made to operate a relay, which disconnects the source of carrier current from the modulator, thereby stopping its transmission over the line. As a result, at the distant terminal the relay controlled by the rectified current falls back, causing an ordinary 16-cycle ringing current to be sent out over the connecting line associated with that particular channel.

In the system where the carrier current is suppressed, the 16-cycle ringing current from the low-frequency line operates a relay which applies to the modulator, through the speech circuit, a current of 133 cycles from a vacuum tube oscillator or other source. This current interacts with the carrier current in the modulator to produce a side band current, differing from the carrier by 133 cycles, which is transmitted to the distant terminal. Here it is demodulated and appears in the voice frequency circuit as a current of 133-cycle frequency. This current operates a relay tuned to this frequency, which in turn serves to send out 16-cycle ringing current over the low-frequency line.

Telegraph.—Carrier current telegraphy is based on the same fundamental principles as carrier current telephony, but in actual operation it employs somewhat different physical arrangements, owing to the differences in the nature of the signals to be transmitted and to the differences between the operating conditions met in the two cases.

In ordinary telegraphy the signalling current consists of a succession of so-called "marking pulses" separated by intervals of zero or oppositely directed current representing spaces. In transmitting telegraph signals over a line by the carrier method, the signalling current, as received from the local telegraph trunk or from a connection long-distance telegraph line, operates a relay which controls the application of carrier current to the high-frequency line. The usual arrangement is such that high-frequency current of uniform amplitude is sent out during the marking intervals only. At the receiving terminal this high-frequency current is rectified generally after amplification by a vacuum tube. The resulting rectified current operates a relay, which in turn sends signals over the connecting telegraph circuit or loop.

It has sometimes been assumed that the only frequency transmitted under these conditions is that of the carrier, and that, therefore, the only limitation on the frequency intervals between the carriers of adjacent channels is that imposed by the degree of selectivity possible of attainment with actual physical apparatus. That this is not the case is easily seen from a consideration of the building up and decay of current in a sharply resonant circuit. If the time required for the current to build up in such a circuit is comparable with the lengths of the marking and spacing intervals, the high frequency current will not accurately reproduce the telegraph signals. This causes a rounding off of the signal, or, if sufficiently extreme, the signals disappear altogether.

To determine quantitatively the relation between the constants of the selective circuits and the speed and quality of the signals, it is most convenient to regard the problem as a case of modulation. As in telephony it was shown to

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be necessary to transmit a band of frequencies equal in width to the voice frequency range; similarly in carried telegraphy it is necessary to transmit a band of high frequencies corresponding to the important frequencies present in the direct current telegraph signals. An analysis of the ideal current wave representing a succession of telegraph signals reveals the presence of an infinite series of components whose frequencies extend to infinity and whose amplitudes decrease with increasing frequency. Ordinary telegraph circuits transmit only components of comparatively low frequency, with the result that the signals are rounded off. Reasonably good signals are secured, however, if those components are preserved whose frequencies are a few times the fundamental interruption frequency. The upper limit of this essential frequency band varies with different types of apparatus and with different grades of service required, but it is for any one set of conditions roughly proportional to the speed of signalling. For the cases so far met with in practice, it is of the order of 100 or 200 cycles. It follows, therefore, that while a modulated wave, whose envelope approximates ideal telegraph signals, would require the transmission over the line of a very wide band of frequencies, satisfactory operation requires the transmission of a band of frequencies equal only in width to the essential frequency range of ordinary telegraphy.

In case of multiplex carrier telegraph operation, the non-essential frequency components are accordingly suppressed by the selective sending circuits, so as to prevent them from interfering with other channels.

It will be seen that the transmission of the high-frequency current is controlled by a relay whose winding is included in the low-frequency line and the contacts of which short-circuit during the spacing intervals the output circuit of the oscillator which supplies energy to the line through an amplifier. At the receiving terminal the arrangement for demodulation or detection requires some further explanation. The carrier current, after suitable amplification, is applied to the input circuit of a vacuum-tube detector. The grid of this tube is made just sufficiently negative to prevent the flow of current in the plate circuit, which includes the winding of a relay, when no high frequency current is being received from the line through the amplifier. During the marking intervals a high-frequency alternating potential is applied to the grid, causing a high-frequency pulsating current to flow in the plate-circuit and operate the relay which is adjusted so as to be held in the operated position for the duration of the signal. The contacts of this relay control the sending of signals over the connecting telegraph circuit.

Referring to the question of multiplex operation, it may be mentioned that where the carrier frequency is of the order of several thousand cycles the percentage difference in frequency between the extreme edges of the side band is so small that it is not so readily possible to design circuits to suppress one of the side bands, as can be done in the case of telephony. For this reason, the frequency range assigned to a carrier telegraph channel has been twice that of the essential frequency-range of the direct-current telegraph channel. As is obvious from previous consideration, the advantages of band filters largely disappear for narrow transmission bands at high frequencies, and in telegraphy it has been found more convenient, for the signalling speed so far met with, to use loosely coupled resonant circuits.

A frequent condition of two-way operation involves what in ordinary telegraphy working is termed "full duplex operation," where the oppositely directed channels are used simultaneously for independent messages. In ordinary telegraphy this full-duplex operation is secured by balanced bridge arrangements which involve at each terminal a close balancing of the actual line by an artificial line. This close balancing at low frequencies is secured by rather close attention of a repeater operator and rather frequent readjustments of the artificial line constant. While it is possible to adapt such an arrangement to the carrier telegraph line, it has not been found economical to do so because of the ease of securing full-duplex operation by the use of different carrier frequencies for the two directions. The extension of this method to multiplex operation is obvious. A very convenient frequency arrangement for carrier telegraphy has been found to be that in which transmisions in one direction occupy a range of frequency from 3,300 to 6,000 cycles, and those in the other direction from very slightly above 6,000 to 10,000 cycles. By proper terminal arrangements this will provide on a single pair of wires the equivalent of ten full-duplex telegraph channels. From what has been said, it will appear that there is left still available a substantial frequency range which may, if desired, be used to provide either other telegraph channels or, if the needs of the service require them, additional telephone channels.

Frequency Assignments.—From the statements regarding filters and the methods of obtaining two-way operation, it will be evident that it is possible to select the frequencies for the various telephone and telegraph channels in a variety of ways. What assignment of frequencies to the various channels is best suited to a particular installation depends upon the engineering and economic considerations involved. For example, where there is only a single pair of wires available and it is desired to secure over this pair as many carrier telephone channels as possible, it may be economical to go to considerable expense in securing sufficient uniformity in the line so that its impedance can be readily balanced by the artificial line networks, thereby making it possible to use the same range of frequency for securing a two-way telephone channel. The harmonic frequency arrangement already described is particularly useful in such a case.

If, however, it is desired to operate carrier systems over a number of pairs of wires on the same lead, considerations of cross talk, which will be explained more fully later in a section dealing with lines, make it highly desirable that different frequencies be used for operation in the two directions. Under this condition it is not necessary to secure the uniformity of line impedance which is required when the same frequency is employed in both directions. Of the possible frequency assignments for the oppositely directed channels, one which has proved very convenient is that in which all of the channels in one direction employ carrier frequencies below a certain value, and all the channels in the opposite direction carrier frequencies above this value. This grouped arrangement simplifies the selective circuits both at the repeater points and at the terminals; for the separation between oppositely directed currents which is accomplished by the balancing of the high-frequency line when the same frequencies are used in both directions may, with this grouped arrangement, be accomplished by a combination of high and low pass filters. A pair of separating filters for use with this assignment of frequencies is necessary. One is so designed that each filter transmits only those frequencies which are assigned to one particular purpose. Such filters would be used for separating into individual circuits the currents used for carrier telephony, carrier telegraphy, ordinary telephony and ordinary telegraphy and thus facilitating their distribution in the central offices.

(To be continued.)

EXPERIMENTS WITH COAL AND OIL AT LEEDS GENERATING STATION.

The results of the recent tests at the Leeds Corporation Electricity Works into the relative costs of coal and oil as fuel were announced at a recent meeting of the responsible Committee. Tests were made between 8 and 11 p.m. on July 14 and 15. Ten tons of coal were used and 11,300 units generated, the consumption being 1.98 lb. at a cost of 1.115d. per unit, compared with last year's coal consumption of 2,859 lb. at .560d. per unit. Several reductions should, however, be made from the workscost if oil fuel only were used, and 7,265 units should be saved in the operation of stoker gear and coal elevator. In the result, it was claimed that oil would have to be £2 17s. a ton to compete with good coal at £1 16s. a ton, or £2 19s. a ton to compete with coal at £1 17s. 6d.

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ELECTRIC LOCOMOTIVES FOR INDUSTRIAL PURPOSES.*

(*Concluded from page 452.*)

Type 2 locomotive is larger, but generally similar in construction to the 1A. It is arranged to work on gauges from 2 ft. to 3 ft. 6 in. With a wheel base of 3 ft. 11 in. it can negotiate curves of 20 ft. radius.

The wheels are 32 in. in diameter, so that it is possible to use standard traction type motors driving direct on to the axles through spur gearing. Two motors ranging from 12 h.p. to 35 h.p. each, according to gauge, voltage and speed required, are controlled by a standard series parallel controller. The maximum tractive effort at the tread of the wheels is 4,000 lb., and the normal speed is from 6 to 10 miles per hour, according to requirements. The total weight of the locomotive is approximately 7 tons.

This locomotive can be equipped with a removable battery compartment, or with a standard bow trolley, mounted on a trolley standard to suit varying heights of wire.

Type No. 3 locomotive is adaptable for all gauges from one metre to 5 ft. 6 in. This locomotive is of the central cab type, with sloping end covers, the ends being made to contain the batteries when these are required.

The general dimensions are:—

Length	... up to 21 ft. over the buffers.
Overall width ...	... up to 8 ft. 9 in.
Minimum height over cab	9 ft.
Wheel base ...	... 6 ft. to 8 ft.

With a 6 ft. wheel base this type of locomotive can operate on a curve of 30 ft. radius. The frame is built up of rolled steel channel iron, strongly braced and riveted together, and it can be arranged for any type of buffer or combination of buffers.

The arrangement in the interior of the cab is comprehensive but simple. A series parallel controller of standard type having 4 series, 4 parallel and 7 braking notches, is fitted, so that the driver can operate the locomotive in either direction without changing his position. In the centre of the cab, and within easy reach of the driver, an operating wheel for the screw-down handbrake is fixed. Gong and sand-operating pedals are set in the floor close to the brake. An ammeter, a voltmeter and an ampere-hour meter are mounted on a vertical panel which is fixed between the two windows at one end of the cab. For trolley type locomotives an ammeter is the only instrument fitted. An automatic circuit-breaker is fixed inside the cab in an accessible position under the roof. The doors of the cab are of the sliding type, and one window in each side can be let down.

This type of locomotive is driven by two traction motors through spur gearing on to the axle. According to the nature of the work required and the voltage available, it can be fitted with motors varying from 15-h.p. to 90-h.p. each. The total weight of the locomotive can be varied from 11 to 22 tons. With the most powerful equipment it will give a normal tractive effort of 5,000 lb., and for short periods 8,500 lb. at the tread of the wheels. With the wide range of standard traction motors available, normal speeds of from 4 to 25 miles per hour can be arranged to suit individual requirements.

With locomotives of 18 tons or over, or where there are heavy grades, it is usual to supplement the hand and rheostatic brakes by an airbrake of standard manufacture, and the brake rigging is so arranged that this can be done without alteration to any standard fitting.

The arrangement of the battery compartments has received special attention. The compartments are weather-proof and fitted with ventilated covers, which, when open, allow for easy access to the cells for purposes of testing and repair. The interior of the compartments is painted with acid or alkali-resisting paint according to the type of battery installed, and when required by the battery maker, the compartment is fitted with an additional wood floor. The whole compartment is strongly braced and supported by an interior channel iron against which the battery is firmly wedged, to prevent displacement due to acceleration and shunting shocks. The maximum capacity of battery which can be used with this type of locomotive naturally varies with the make of battery preferred and with the available charging voltage. In round figures, however, the capacity is 130 kw. hours.

The motors are standard series interpole traction motors exactly similar in type and construction to those manufactured in large numbers for tramways and light railways. They are manufactured, in common with all traction equipments, at the English Electric Company's Dick, Kerr Works, Preston.

The controller and under-car type resistances likewise present no new features from those proved by continuous use on existing systems.

The charging of the battery is carried out by connecting the supply to the battery by means of a socket and plug in the locomotive, and through a two-way charge and discharge switch which connects the battery through the circuit-breaker and an ampere-hour meter either to the supply or to the controller. The ampere-hour meter indicates the capacity of the battery both during the charge and discharge, and is so arranged that on reading full charge an auxiliary tripping coil in the circuit breaker is energised, thus opening the circuit between the battery and the supply.

The tripping coil is open-circuited by means of auxiliary contacts on the charge and discharge switch when the latter is set for operating the locomotive.

When batteries are fitted which consist of more than 160 cells in series, they are divided in half by an ironclad single-pole sectionalising switch to minimise the risk of shock when the cells are being examined and tested.

The main cabling is run in steel tubing.

For operation on a trolley system, part of the apparatus mentioned above is, obviously, not required, and the locomotive is then fitted with a standard current collector, fixed to a trolley plank firmly secured to the top of the cab. A lightning arrester of standard tramway type is also provided.

In the locomotives described above a wide range of requirements has been compassed with the minimum number of types. They are all constructed with a view to operating under severe conditions, having short wheel bases and being of robust construction to withstand the vibration and shocks due to indifferent track. In common with all standard electric stock, they are easy to operate, can be brought to rest exactly at the position required, and possess a high and constant acceleration up to a relatively high speed.

In conclusion, it is believed that the substitution of electric for steam traction for industrial purposes should materially contribute to reducing the present-day cost of production. The direct saving that would be effected is alone sufficient to justify the most careful study of the question by all users of industrial locomotives. But in addition there would be a very important economy effected in the national coal bill owing to the more efficient use of that product, and a still further saving on ton miles of coal hauled on the railways. It may be expected, therefore, that electric industrial haulage will result in increasingly efficient and economical production as this system comes to be generally adopted.

* *English Electric Journal.*



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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 123.

I desire a protective device for tripping a circuit breaker in the 20 to 33 volt generator main of a motor generator which is used for charging a battery of 12 cells. The breaker should trip under the following conditions:—

1. When a reverse current of 15 per cent. of the normal charging current flows through the generator armature.
2. When an overload of 50 per cent. flows for a predetermined period of, say, 10 minutes.
3. When the supply pressure to the motor falls to 50 per cent. or less of the normal supply pressure. The output of the generator is 300 amperes at 20 volts.

(*Replies to Question No. 123 must be received not later than August 27, 1921.*)

Answers to Questions.

QUESTION NO. 119.

There were some fuse boards recently delivered to our works. The fuse clips are fixed to iron rods insulated with what appears to be mica or micanite. I would like to know how mica is placed round the iron rods in this manner, and what material I shall require to insulate the rods if a breakdown should occur.—"CLIP."

REPLIES TO QUESTION NO. 119.

The first prize (10s.) has been awarded to "D. J. Wilson" for the following reply:—

In the makers' works these tubes are made by special machinery. "Clip" will find it much cheaper to buy micanite tubes of the correct size and saw them with a fine tooth hack-saw to the required length, than to mould them on the job. They can be purchased (cut to length, if desired) from the firms who advertise from time to time in ELECTRICITY.

In the event of a breakdown, with no ferrules on hand, they can be moulded as follows, using thin micanite sheets for small tubes and thicker for the larger ones. Cut the micanite sheet into strips a little wider than the finished length of the ferrule, and long enough to make two or three turns round the ferrule.

Procure a turned mandrel slightly smaller than the internal diameter of the ferrule (the mandrel should be slightly tapered), and provided with a shoulder of, say, ¼ in. a side, at a distance equal in length to the length of the ferrule from one end.

Two or three layers of brown paper should be stuck to the mandrel (with shellac), this will be burned during the process of baking and will, therefore, facilitate removal.

The strips must now be soaked in shellac varnish and then bent into shape around the mandrel. This must be done with care; the mandrel may be fixed in the vice.

The edge of the micanite must be kept on to the shoulder, and the turns must be kept as tight as possible. Bind temporarily in this position with a few turns of fine wire, and then bake by holding a chunk of red hot iron close to the micanite. When the varnish has burned off, another layer of micanite must be wrapped and burned as before, care being taken to remove the binding wire at each stage. If any layer does not seem to have stuck properly to its mates, it must be revarnished and baked until it does. This should be done before removing the temporary binder. When the ferrule is a little larger than required, it should be taken off the mandrel and filed up all over (in the fingers), making the outer periphery a little smaller than the finished size. A brown paper coat should be shellaced on and bound, baking slower this time in the motor stove, or in front of an open fire. This is a messy and expensive operation, and a reliable substitute can be made in half the time by using one continuous strip of leatheroid, well soaked in shellac, and baking at about 180 degrees F. The finishing coat should be of tape, fixed with chatertons, and soaked in shellac (after taping), drying rather slower this time. The tape should be narrow compared to the length of the ferrule.—"D. J. WILSON."

The second prize (5s.) has been awarded to "M.M." for the following reply:—

To roll mica round small rods will be found to be a very difficult operation. Such an arrangement was produced in America, but the method of manufacture was a trade secret. If "Clip" must have mica, the material known as "mica cloth" might be found satisfactory. This cloth is made by cementing thin pieces of mica on a flexible base; the combination may be rolled round pins of comparatively small diameter. Micanite would probably do for the purpose, provided cost was not excessive. The writer recommends asbestos for the required purpose. Cut slips of good asbestos millboard to suitable dimensions and soak them in water. While the asbestos is wet it may be wrapped round the pins and moulded into the necessary shape and size. When dry, the asbestos will be found to be quite firm. It would be a very simple matter to make up a few of these insulating cylinders on formers, and thus have a supply ready for replacements.—"M.M."

ANSWERS TO CORRESPONDENTS.

Mr. J. PLUMMER (Peckham).—Many thanks for your letter. It is hardly possible for us to look through every text book to see if prizewinners' replies are entirely original. The competition judge first considers the question, and then selects the reply which, in his opinion, meets every requirement in the question. We desire to assure you, however, that, as far as we know, original replies are selected.—Editor, ELECTRICITY.

Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

POWER HOUSE DESIGN. By Sir John F. C. Snell. 2nd Edition. Cr. 8vo, 535 pp., with 20 folding plates and 202 illustrations. (Longmans. 42s. net.).—For the last year or so, central station engineers, plant contractors and engineering students have been looking forward with keen interest to this promised new edition of Sir John Snell's well-known text book, and now that it has been published, a careful perusal thereof convinces us that it well deserves the hearty reception it is sure to meet with. From start to finish it is a first-class work, full of most interesting and valuable data and information regarding the design and construction of typical power stations, together with well-reasoned conclusions based on their working results. The author, assisted by other gentlemen, to whom he gives generous acknowledgment, has gone to great care to in-

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clude details of the most up-to-date machinery and plant required for modern power houses. The examples illustrated range from Greenwich to Glasgow, Belfast to Buenos Aires, Barking to Bahia Blanca, New York to Melbourne, and, indeed, all that may be deemed "the best practice" for the particular requirements of the case. One great drawback to which Sir John refers with regret is that, owing to the great variations in prices brought about by the war, he has had to base all his cost figures on pre-war prices, and readers must allow for this in figuring out estimates, which will apply to the country in which they reside, but that difficulty must be faced boldly, and as the tendency is now steadily tending to a world-wide reduction in prices for both materials and labour, the difficulty will gradually tend to disappear. At any rate, as a standard text book, it can be recommended to our readers without hesitation.

HIGH-TENSION SWITCHGEAR. By Henry E. Poole. 118 pp., 26 figs. (Pitman. 2s. 6d. net.).—Little need be said except that the more important points in the design of the leading types of apparatus employed in the control of H.T. electrical plant are dealt with in a general way. The subject being highly specialised and most intricate does not readily lend itself to this kind of treatment, and the author has done well in a difficult position, but a more general or a more thorough treatment of such a subject is preferable. Two-thirds of the space is devoted to oil switches and the remaining third to isolating links, arrester gear, fuses and testing. A bibliography of papers whence further information on the apparatus and practice referred to may be found is given.

Various Items.

Personal.—The Rt. Hon. Earl Buxton, G.C.M.G., has accepted an invitation to join the board of the British Thomson Houston Co., Ltd.

Will.—The will of Mr. T. E. Gatehouse, of 128, Tulse Hill, S.W., late editor and director of the "Electrical Review, Ltd., has been proved at £23,345.

For Sale.—An advertiser has for sale a complete ten-way inter-communication telephone system, in perfect working order. For particulars see a small advertisement.

Business in South Africa.— Mr. W. G. Wickham (H.M. Senior Trade Commissioner in S.A.) is at present in this country, and will discuss trade possibilities, etc., with British firms. London firms who are desirous of consulting Mr. Wickham should communicate immediately with D.O.T. (35, Old Queen Street, S.W.1), quoting the reference 3092/T.G., and indicating briefly the subject on which the interview is desired. Mr. Wickham will subsequently visit some of the principal industrial centres of the United Kingdom.

Keighley.—The T.C. has received an intimation that the Corporation E.L. Order giving power to supply electricity for lighting and power purposes to various places in the district is to come into operation on Sept. 1. The Order has been held up since 1915, and it is thought that, now it has been granted, there will be a considerable increase in the revenue of the Electricity Dept. of the Corporation, and a new high-tension overhead cable to supply power to large stone quarries at Eastburn and to augment the supply to the Sutton trackless tram route is already being laid, and many inquiries and applications for electric supplies from the districts covered by the new Order have been received.

The Batti-Wallahs.—This well-known society is asking its members to vote on various subjects, including the following:—the day of the week, Monday or Friday, most convenient for the nine monthly luncheons, whether the Holborn Restaurant or the Hotel Cecil is preferred. The question of the number of "Informals," a Ball, Smoker, Golf and Tennis Tournament, Summer Outing up the River, etc., are also on the list for suggestions, as is the proposed date of the annual dinner (March 31) and the resumption of the quarterly Journal. The society is showing many signs of vigour, and we hope that the Hon. Ent. Sec., Mr. A. J. Greenly (37-8, Strand, W.C.2), will receive all the forms carefully filled up.

The Government Accounts.—In the third report of the Committee of Public Accounts reference is made to the question of Government Accounts not always being presented in comparable form. The report states:—"We regard the institution and businesslike compilation of these trading accounts as of the greatest importance in affording an effective instrument to bring about economies. As a small illustration we may refer to the comparative cost of two-power stations, both under the Postmaster-General, which is revealed in the accounts now for the first time published and brought under scrutiny. In one case the unit cost works out at 2.92d., in the other (a very much smaller concern) at 6.52d. The latter station has now been ordered to be closed down."

Trade Notes.

Grey and Co. (S. T. Oldridge), of 7, Market Place, Oxford Circus, W.1, announce that they have succeeded in producing a substitute for platinum. It is called "Platact," and there is claimed for it low cost, convenience in handling, long life and increased conductivity.

It is announced by the manufacturers of "Xcel" heating and cooking appliances, the **Automatic Telephone Manfg. Co., Ltd.** (Milton Road, Edge Lane, Liverpool), that they have recently made considerable reductions in price.

Particulars of a new calling system to find any one of 45 men scattered throughout a works or other industrial organisation and to bring them to the nearest inter-departmental telephone in the minimum time are given in a descriptive pamphlet just issued by **Dictograph Telephones, Ltd.** (Aurelia Road, Mitcham Road, Croydon). The system is distinct from the telephone, and consists of a line of bells, horns, buzzers, or other signals distributed throughout the works and operated from a sending instrument near the exchange. Each individual has a special call, which is repeated at intervals till he answers the telephone.

The Sun Electrical Co., Ltd. (118 and 120, Charing Cross Road, W.C. 2), have just issued a number of leaflets and a booklet dealing with the A B C Super Electric Washing Machine and A B C Ironer—a device which justly enables the complete device to be designated the A B C Electric Laundress. For a full description see the issue of ELECTRICITY for June 16, 1921, page 317. Interested readers should apply to the Sun Co. for copies of the leaflet.

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ELECTRICITY
A PRACTICAL TRADE JOURNAL
SEPTEMBER 2, 1921.

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NOTES ON ASYNCHRONOUS GENERATORS.

By J. W. Rogers.

Notwithstanding the fact that the asynchronous generator possesses certain advantages when operated in conjunction with synchronous machinery on large alternating current systems, there are comparatively few examples of its application in modern practice.

The asynchronous generator possesses several operating characteristics which can be more readily understood by considering a few elementary facts connected with the working of an induction motor, as this type of machine can be operated as a generator under certain conditions. With reference to the three-phase type of induction motor, when a three-phase current is supplied to its primary winding, a rotating magnetic field is set up, which also passes through the secondary winding, generating therein a series of alternating E.M.F.s which cause currents to flow in it.

The reaction which takes place between these induced currents and the rotating magnetic field causes the motor to rotate at a speed approaching its synchronous value.

The rotating magnetic field due to the primary current revolves round the rotor at a constant synchronous speed, which depends upon the frequency of the supply current, and varies inversely with the number of poles on the motor.

As the currents induced in the rotor winding tend to oppose the motion producing them, the rotor will revolve in the same direction as the rotating field set up by the supply current, the tendency being to prevent its conductors being cut by the field. If it were possible for the rotor to run at its synchronous speed (while the machine was running as a motor) it would cease to be acted upon inductively, and would, therefore, exert no turning effort, due to the fact that under these conditions the rotor and rotating field would be stationary with regard to each other, consequently no induced currents, which are necessary for developing a torque, would be generated in the rotor winding.

The difference between the "no load" and the synchronous speeds of an induction motor is termed the slip; it is expressed as a percentage of the synchronous speed, and varies with the load on the motor.

When power is supplied to drive the rotor at a higher speed than that of the rotating magnetic field the angular speed of the latter, also the slip and torque, will be negative, consequently the machine will act as an asynchronous generator, but only under certain conditions.

As an induction motor is not self-exciting, it will not generate any voltage when driven above its synchronous speed.

If, however, such a machine has its stator winding connected to a three-phase system, and the rotor be driven above its synchronous speed by power supplied to the shaft, the E.M.F. generated will be higher than the impressed voltage, therefore the direction of the current in the rotor windings will be directly opposite to that when the machine is motoring.

A reversal of the rotor current will cause a reversal of the stator current, therefore the machine would be operating as an asynchronous generator, and deliver current at the same voltage and frequency to the supply system.

The current returned to the system would depend upon the speed and resistance of the rotor windings, and if the value of this resistance was kept constant the current would depend upon the speed and frequency.

When an asynchronous generator is operating under the above conditions, it acts as a booster and increases the line voltage, the value of the voltage generated depending upon the general characteristics of the machine, such as its effective reactance and the line current.

If an induction motor is only driven at its synchronous speed while connected to the supply system, it follows from the above remarks that no current will be generated in the rotor windings.

Although the machine would be neither generating nor motoring under these conditions, it would still be taking a small wattless current from the system to supply the magnetising losses.

It is of interest to note that when an induction machine is run in the opposite direction to its normal rotation as a motor it will not return current to the system, but takes sufficient energy therefrom to supply all the magnetising losses, and if the normal voltage is applied to the stator windings under the above conditions, the current will exceed its locked value unless a high resistance is inserted in the rotor circuit.

As the frequency of the rotor currents is directly proportional to the product of the slip (expressed as a percentage of the synchronous speed) and the frequency of the stator current, it would be about double that of the latter when the machine was running at its synchronous speed under the above conditions. The current flowing in the stator winding of an asynchronous generator may be divided into two components, viz. :—

(a) An energy current supplied to the load.

(b) A wattless or magnetising current, which must be supplied by the synchronous plant working on the system.

The chief disadvantage of an asynchronous generator is that its power factor is always less than unity, unless the lagging wattless component which causes this reduction is compensated by a separate over-excited synchronous motor, or other leading component, so far as its current input is concerned.

As the wattless or magnetising current must be supplied from the system, if the synchronous generating

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plant be shut down, the synchronous generator would be deprived of its excitation, consequently its voltage would drop to zero.

Operating Characteristics of Asynchronous Generators.—The operating characteristics of asynchronous generators are such that it is only necessary to run the machines up to or near their synchronous speed before connecting them to the system, which renders synchronising gear, also skilled attention, unnecessary, as all regulation is effected on the synchronous generating plant.

These advantages are of considerable service in power stations liable to a sudden increase in load, as the asynchronous generators can be run light as induction motors at speeds just below synchronism until they are required to pick up the load, which is effected by simply raising the speed of their driving units.

The operating characteristics of an asynchronous generator, when working in parallel with synchronous plant, may be considered as follows:—

Under these conditions the frequency of the system is determined by that of the synchronous plant, and when the speed of the latter is reduced the asynchronous generator will pick up more load due to the increased slip between its rotor and the rotating magnetic field set up by the stator current.

When an increase in load occurs on the system it is first taken up by the synchronous plant, the speed of which is slightly decreased. This speed reduction causes a corresponding decrease in the speed of the rotating fields on the asynchronous generators, which would then pick up the load.

The parallel operation of asynchronous and synchronous generators has also a tendency to minimise the rush of current, which occurs when a short circuit takes place on the system.

This is due to the fact that a dead short circuit would cause the terminal voltage of the synchronous generators to drop nearly to zero, consequently the asynchronous machines would lose their field and generate no current.

It follows, therefore, that asynchronous generators are not liable to be damaged by short circuits, and they may be connected to the system without synchronising after the short circuit has been removed, when they will immediately take up the load if the synchronous plant in operation is of sufficient capacity to supply the necessary magnetising current.

As regards the question of power factor, it must be admitted that the operating characteristics of an asynchronous genreator have a bad effect on the system, as it tends to increase the wattless currents already existing therein, due to an inductive load.

As it is of considerable importance to keep the power factor of alternating current systems as high as possible, the effect an asynchronous generator has on the system can only be regarded as a serious disadvantage.

The wattless currents required by asynchronous generators can be conveniently supplied by synchronous motors when these form part of the load on a system. When there is sufficient synchronous motor capacity available on a system it is not necessary to run synchronous generators in parallel with asynchronous machines, but the necessity for starting and exciting these motors from some auxiliary plant must be taken into account, when considering the advantages of either method of supplying the wattless currents required by asynchronous plant.

The above considerations indicate that it is simply a question of providing the wattless current to obtain satisfactory operation of asynchronous generators.

Although a large amount of capacity will assist in balancing the wattless component, the capacity which exists in a system under normal conditions is not sufficient for this purpose.

The chief disadvantage of the asynchronous generator is that it is necessary to have synchronous plant operating on the system to supply the wattless current, and for this reason it is considered unsuitable for ordinary central-station service.

As is well known, synchronous motors are capable of delivering mechanical power, in addition to supplying the wattless currents in a system, and when these machines are operating under such conditions it is generally advantageous to employ asynchronous generators.

The regenerative characteristic of asynchronous motors is of considerable service when these machines are used for traction work, as they are capable of acting as brakes and returning current to the system when trains are descending gradients.

Although the application of the asynchronous generator is of considerable service in large alternating current power plants, there is little scope for its advantages in ordinary central-station practice, due to the fact that it is not self-exciting and increases the wattless currents in the system.

THE BRITISH "BULL."

AN ELECTRIC LIGHTING SET FOR HOUSE OR FARM.

The advantages of electricity for lighting and small power purposes in the home, farm and factory, as repeatedly referred to and appreciated by most people, render its provision an economic necessity; and this aspect will not further be considered here. In this country the slow proceedings with regard to the formation of the much advertised "electricity districts," whereby many had been led to hope for a cheap supply of electricity all over the country from generating stations, show that, after all, progress will be probably made only on pre-existing lines, and the self-contained set is destined to provide the supply for many a house, farm and factory, as well as for many railway stations, churches, hospitals, schools, clubs, hotels, kinemas, etc., while it has a further use on yachts, trawlers and other vessels of moderate size.

Prime necessities to be embodied in the design of such sets are reliability, robustness and efficiency, the two former needing substantial construction and a moderate speed. A recent 1 kw. set embodying these points is the "Bull" lighting set, marketed by Agricultural and General Engineers, Ltd. (Central House, Kingsway, W.C.2), the engine being manufactured by the well-known firm of Peter Brotherhood, Ltd., of Peterborough, and the generator by A.G.E. Electric Motors, Ltd., of Stowmarket, both of which firms are now branches of the former.

The engine is of the four-cycle type, suitable for petrol, benzol or town gas. It is of novel and simple construction, containing fewer parts, it is claimed, than any other four-stroke engine. A special feature is the combustion chamber, designed to ensure perfect combustion and high fuel economy, whilst the water jacket is readily accessible for cleaning by removal of the cover, and the entire construction, including the governor, follows most approved lines. The flexible coupling consists of rows of "Ferodo" rings carried on bolts secured to the generator, and fitting into corresponding holes in the engine fly-wheel, a construction which makes it possible to remove the generator altogether, without dismantling the engine, should this be

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desired at any time. The generator frame is of forged steel, with detachable steel pole pieces fitted with laminated tips. The brushes have ample contact area, are adjustable for pressure and position, and are easily accessible.

As shown in Fig. 1, the switchboard is carried on brackets bolted to the generator casing, and can be supplied in two standard types, A and B. In type A, as illustrated, a hand-operated starter provided with insulated contacts is arranged to short-circuit the magneto when in the off position. A small catch (normally held out of action by gravity) is provided, which is capable of holding the starter handle in an intermediate position to allow for hand-starting the engine should this at any time be necessary. As the handle is moved across the quadrant the battery drives the dynamo as a motor, and as soon as the engine attains speed a current is generated which either passes to the battery or the lights. Contacts are arranged to alter the number of cells to give a reasonably constant voltage on the lights,

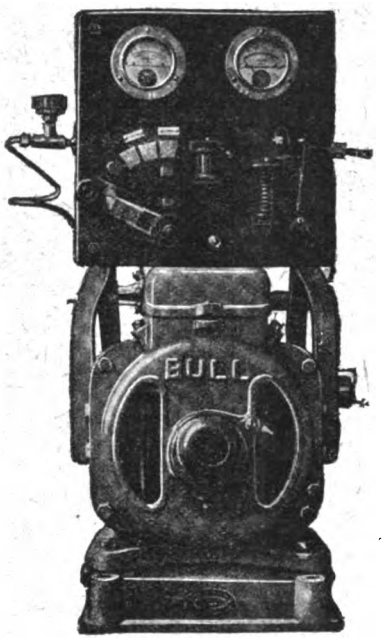


FIG. 1.

while charging, and the handle is held in the charging position by a magnet so long as is required, or until the battery is fully charged. In the event of the fuel supply being cut off the starter will immediately return to the off position and the whole set will be shut down automatically. A very special feature, which adds to the reliablity of the reverse current and overload tripping switch, is that it is polarised from the battery, and no permanent magnet of any kind is used on this part of the equipment. The mechanism is, therefore, unaffected even should a very heavy current be accidentally passed through it. Stated shortly, this arrangement provides self-starting, by moving over a lever, and automatic stopping in case of lack of fuel or other causes.

In type B, a starting switch, which is automatically released as soon as the engine starts and, at the same time, automatically keeps the voltage on the lamps approximately constant during both charging and discharging, is included. The current passing into or from the battery is registered by an ammeter having a central zero position, and the state of the battery is indicated by a meter, which has a scale marked "Battery Empty," "Battery Full." This meter is worked from the battery voltage, and contacts are provided so that when the battery is empty a warning signal, such as a bell, can be rung, and when the battery is full a hand on the meter closes contacts and automatically shuts down the set. If it is wished to shut down the set before the battery is full a press button is provided for this purpose, and connections can be taken from the board to a switch, enabling the set to be controlled from a distance should it be so desired. Alternatively, the board can be fitted with an ampere-hour meter indicating the current passed into or from the battery, and enabling the latter to be charged to a predetermined amount. The separate volt and ammeters

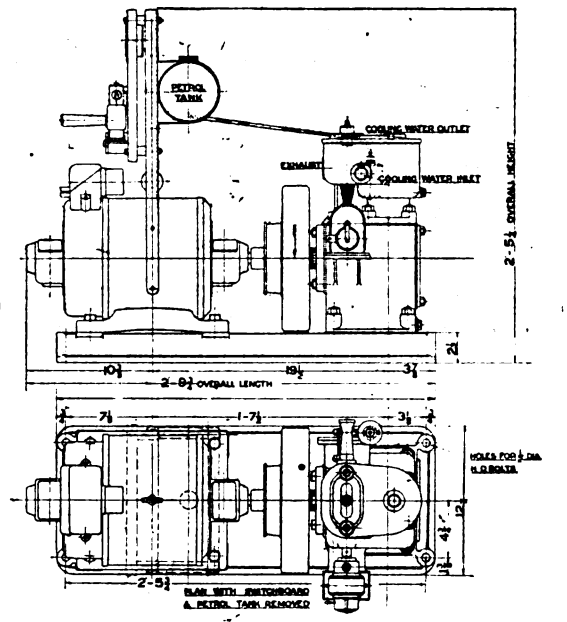


FIG. 2.

are, however, recommended. In brief, this arrangement provides self-starting, automatic control of running periods, warning of becoming exhausted and practically constant lighting effect.

Further details of the set can be gathered from Fig. 2. The usual battery supplied is of a standard British make of 72 or 120 amp.-hr. capacity, and the complete set is available as follows:—

Type.	R.P.M.	Volts.	*C.P. from Battery for 10 hrs.	*C.P. with Engine running.
1	1250	24	345	1205
1A	1250	24	575	1535
1B	1300	25	360	1360
1C	1300	25	600	1600
1D	1300	50	720	1720

*Using Gasfilled Lamps.

With regard to cost of operation, the Company themselves say:

"No exact figure can be given for this item without knowledge of the actual conditions under which any given set is working, as much depends on the number of running hours, load and other factors. Assuming, however, the plant to be installed for lighting purposes in a house of moderate size with a total of, say, 40 ½-watt lamps averaging 12-candle power each, of which, experience shows, not more than 12 are, as a rule, burning at a time, the 72 ampere hour battery will supply the necessary power for 24 hours without recharging (120-A.H. battery would give 40 hours under the same conditions), and the plant would therefore be required to run on an average not more than five or six hours per week throughout the year.

"The cost of running with petrol at 3s. 6d. per gallon would be about 6½d. per hour, and with town gas at 5s. per 1,000 feet about 3d. for the same period. The total

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weekly running cost would therefore vary from approximately 1s. 6d. to 3s. for a house of the size mentioned."

Further, they have prepared a graph showing the cost of operation, some of the values being as under:

FUEL.—*Cost of Fuel (or per 1,000 cu. ft. per gallon).*		*Cost per 100 C.P.-hrs. *(with Gasfilled Lamps.)*
PETROL OR PARAFFIN	1s.	.11d.*
	2s.	.22d.*
	3s.	.32d.*
	4s.	.42d.*
GAS	4s.	.13d.*
	6s.	.20d.*
	8s.	.27d.*
GAS BURNT IN INVERTED MANTLE	4s.	.39d.
	6s.	.59d.
	8s.	.75d.
GAS BURNT IN UPRIGHT MANTLE	4s.	.74d.
	6s.	1.10d.
	8s.	1.46d.

TRAIN LIGHTING MAINTENANCE.

By H. S. B. ROBINSON.

Only a slight knowledge of the traffic conditions is necessary to enable the reader to readily understand that the position occupied by railway generators, like that of tramway motors, renders the machines extremely liable to breakdowns, and unless special precautions are taken great inconvenience will be caused to passengers, especially on long distance trains. In addition to the generators, the batteries and cut-outs also require special attention, from which it will be seen that maintenance work in connection with train lighting equipments is a matter of utmost importance, as failure on long-distance trains cannot be rectified until arrival at destination. It is proposed, therefore, to deal with these componets in the order mentioned.

Dynamo.—When testing, it must not be forgotten that the machine is designed to run only on a closed circuit such as that provided by the battery. In case of a failure of the belt and to prevent the dynamo swinging down, a chain should be slung round the machine or a tension rod may be provided. The belt, if properly arranged, should not slip, no matter what the speed may be, as the correct tension is given by the weight of the dynamo, which is slung out of the vertical, the covers of the oil wells of course remaining in horizontal position. The oil wells must on no account be filled higher than the overflow pipe, the closing plug of which should be unscrewed during filling. The actual level of the oil should be some 5 inches from the lid of the oil well.

Battery.—Should it be considered advisable at any time to charge the battery at the maximum rate in spite of the regulator, as, for instance, after a coach has been in the shops or on a siding for some time, the operation of the regulator in respect of over-charge can be temporarily stayed by closing the short-circuiting switch. When cells are fitted with indicators the state of charge, as well as the level of the electrolyte, may be seen at a glance, as, for instance, one (pale blue) floating bead would indicate that the cell is nearly discharged, two (pale blue and yellow) beads about a quarter discharged, three (pale blue, yellow and dark blue) beads fully charged. On no account should the pale blue bead be allowed to sink, as this indicates that the cell is completely exhausted. The cells must not be allowed to stand discharged, but must be kept filled with electrolyte so that the plates are covered at least half an inch. Loss due to evaporation can be made good by adding distilled or pure rain water. If the cells are only used at intervals an extra charge once a week for about two hours will keep them in good condition. All metal connections should be kept smeared with vaseline to prevent corrosion. Proper ventilation is necessary for the gases to escape, and on no account must a naked light be brought near the cells when charging. In connecting the cells, the surfaces of the lugs of both flexible connector and sections should be scraped clean and the bolts, nuts and washers smeared with vaseline before and after they are tightly screwed up.

Cut-out.—To test the cut-out, connect to dynamo and lift up the armature of the relay. The switch arm should then be automatically held on the "off" position and the relay armature should assume its original position on being released. The cut-out lever must on no account be pushed into the switch by hand unless the battery connection is previously broken, the carbon break must, of course, be in good adjustment.

Main Fuse.—Should the main fuse blow from any cause and not be immediately replaced, the dynamo will run on open circuit, and the effect will be that the shunt field current will rise above the normal. To protect the windings, the shunt field fuses will then also blow. It follows, therefore, that when replacing a broken shunt fuse attention must be given to the main fuse that it is intact, as otherwise the former fuse will immediately blow again. Inserting heavier fuse wire than is actually required may be attended with serious consequences for the windings, as may be gathered from above remarks.

Resistance.—In equipments where first cost is of such importance that the use of a regulator is not considered necessary, a lamp resistance should most certainly be employed. This automatically inserts resistance in the lighting circuit whenever the necessary charging voltage of the battery exceeds the working voltage of the lamps. Its action is necessarily much less precise than that of the regulator, but excessive over-running of the lamps is effectually prevented.

SOUTH AFRICAN TRADE.

In the report prepared by Mr. W. G. Wickham (H.M. Senior Trade Commissioner), and just issued by H.M. Stationery Office at 1s. 3d., reference is made to the backwardness of the engineering industry and the need of generating stations for more plant. As regards trade prospects Mr. Wickham states that there is no reason to suppose that the market is seriously over-stocked, and now that the bulk of orders placed overseas have been filled, it is probable that the situation will rapidly right itself. In spite of financial difficulties there has been no material or general break in local prices. Demand is not likely to become normal until local prices become easier. Even so, British manufacturers must realise that while the local industry may not at present be capable of supplying local needs in full as in Australia and the Argentine, the potential demands for imports of the South African market have been permanently reduced as the result of the developments of the past few years.

It is interesting to note that with regard to imports of electrical machinery and material other than cables and wires the U.S.A. supplied £377,000 out of £1,177,000 worth, a very much reduced proportion.

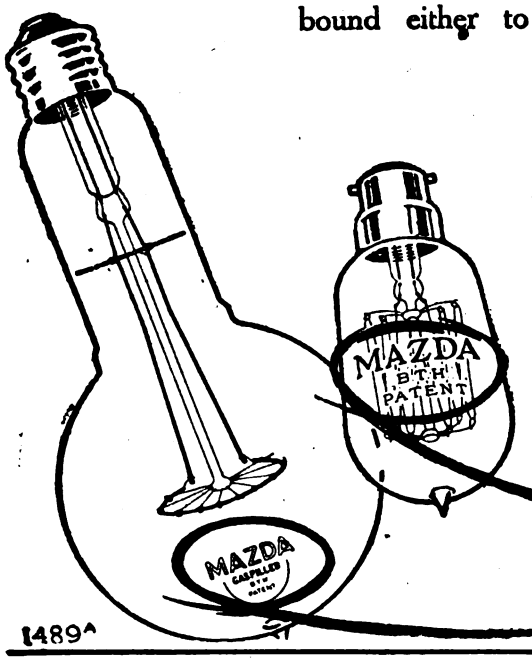
Coming to University Education, it is noted that important developments are in progress. Capetown is building a university on an ample scale. Johannesburg has converted its School of Mines and Technology into a University College, and is hoping for a charter to create an independent University. In both cases new buildings and new equipment are involved, and excellent opportunities are afforded to British manufacturers of being first in the field with donations of apparatus, machinery and other equipment for laboratories, both scientific and engineering. There is probably no form of advertisement—to put it on its lowest plane—so remunerative as making sure that the rising generation of chemists and engineers are taught as household words the names of the makers of plant and apparatus. Optical instruments, laboratory supplies, assay apparatus, testing machines and instruments, engines, machine tools of all kinds, all find a place in such educational institutions, and the makers of such who are fortunate enough to obtain a place for their makes in college laboratories have an obvious advantage over their rivals in all succeeding years.

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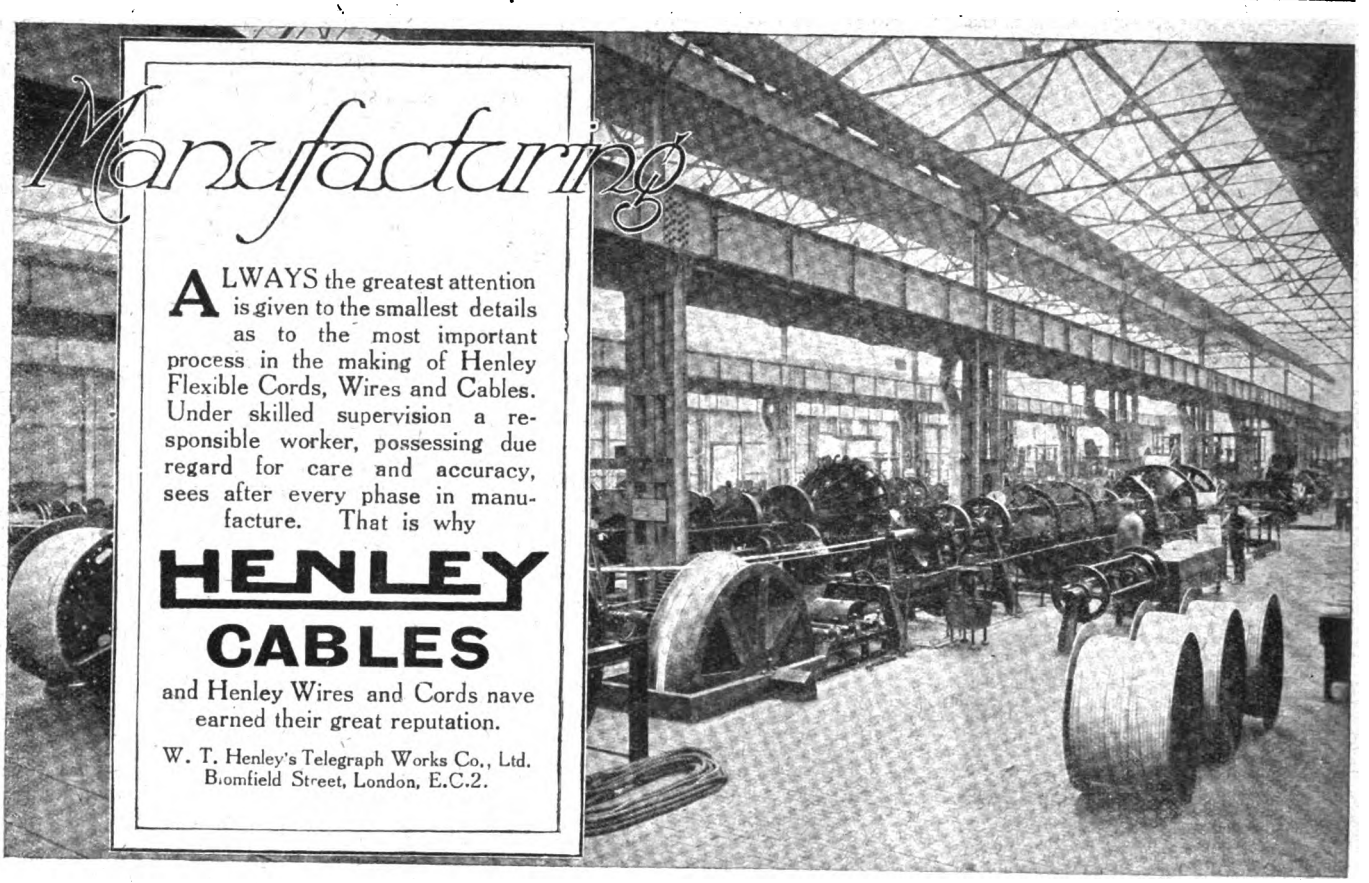
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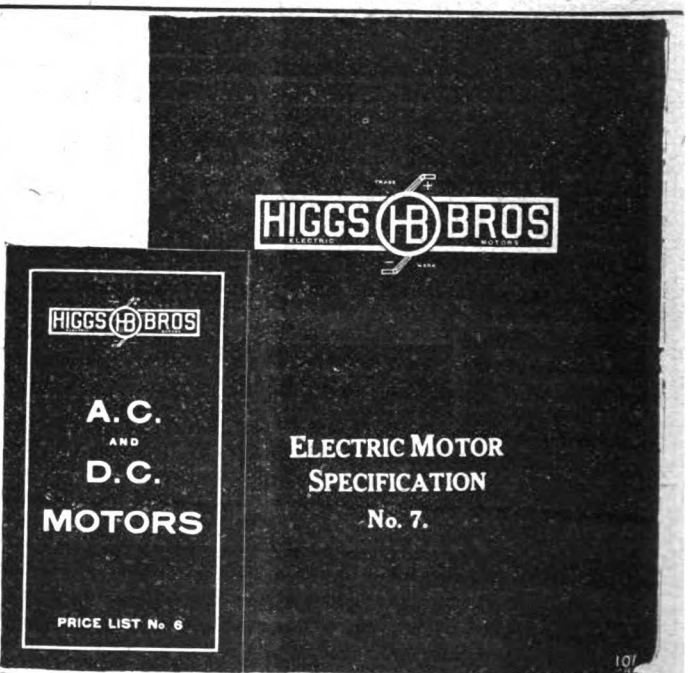
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 6d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Waste.

The war, with its aftermath of squandermania, has familiarised us with the possibilities and consequences of wholesale waste and destruction on a vast scale. According to natural laws there can be no actual destruction of matter; it is simply converted by fire, explosion, shock, corrosion or other factors into other forms, and the original solid or liquid materials may change their form and become gases, other solids or other liquids as the case may be. Waste is either preventable or unavoidable; the terrible disaster involving R38, the largest dirigible, is an example of the latter. The destruction of this air-ship was accidental and unforeseen, and, apart from the regrettable loss of life, involves a waste of some half a million pounds' worth of highly specialised engineering productions.

An example of preventable waste is that incidental to the neglect and flooding of the various coal pits during the recent strike. Due to the accumulation of water in the workings, the withdrawal of essential regular attendance upon valuable plant and machinery and the consequent rapid depreciation of thousands of pounds' worth of modern coal-getting, pumping, ventilating and colliery electrical gear, this strike, which was avoidable and has left both disputants practically in *status quo*, has resulted in enormous and preventable waste.

In this connection few readers, except those actually engaged on colliery work, can realise what a hopeless condition some of the gear was in at those pits whose workings have been submerged for several weeks. I saw a piece of apparatus from a flooded pit opened up the other day. It was a flame-proof cast iron enclosure, with machined flanges, which were not, of course, proof against the ingress of water, and as a consequence the enclosed electrical parts had been submerged the whole time. Iron and steel portions were red with rust, a thick layer of which also covered ebonite and terminals. As a natural result all electrical insulation had gone by the board, and in this particular instance the apparatus was too far gone to repay renovation.

There must have been thousands of similar insfances where it will be necessary to scrap costly modern appliances and replace them with new. So much the better you may be inclined to argue. It's all good for trade and creates more employment. In a way this is true, but the inevitable reaction must be felt in the cost of coal-getting, for all the costs of replacing and reconditioning colliery plant appear on the debit side of the cost per ton at the pit-head and indirectly influence the demand for British coal by the price at which we can afford to sell it in competition with the foreigner.

Moreover, reverting to the general question of avoidable waste as against legitimate wear and tear and normal consumption of manufactured products, there is one item which can never be replaced, and that is the many weary hours of human toil which have been expended in fashioning the finished article from the raw materials. The market price of the latter is determined by the inevitable law of supply and demand, and, if we wilfully waste materials in this wholesale manner by producing thousands of tons of high-grade manufactured plant and machinery, and subsequently have to scrap the finished product before it has served its useful life, our avoidable waste is threefold, viz., the wastage of raw materials, the labour put into the manufacture of the product, and the labour incidental to recovering the greatly depreciated materials from the spoilt product.

It will thus be seen that although war is bad enough with its wholesale destruction of life and wealth, industrial waste through strikes and other causes may well run it close and almost equally threaten our future well-being as an industrial nation. The three factors most threatened by waste of this kind are, in the order of importance, life, energy and material, and it is an indisputable fact that during the past decade we have been overindulging in wastage of all three, for the greater part preventable. Let us see to it that there is a gratifying reduction in the next few years. The old adage—"Waste not, want not," is an excellent precept.

Incompetence.

The uplifting of the status of the electrical engineer by the granting of a recent Charter to the Institution should have a gratifying effect in due course upon the class of man who is entrusted with responsible positions. It is too often the case that a thoroughly incompetent individual, self-styled "electrical engineer" or "electrician," takes a job where he has charge of valuable plant about which he knows little or nothing, and aims at getting the necessary experience at the expense of his employer. As H.M. Inspector of Factories recently pointed out, although many firms

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employ competent electrical engineers, other firms do not appear to realise that the supervision and upkeep of a large and intricate electrical installation is a matter which cannot be safely entrusted to unqualified persons. Many firms who have changed from steam to electric driving have placed their electrical plants in the sole charge of promoted engine-wrights and mill tenters, and appear to have implicit faith in the knowledge and judgment of such men regarding electrical matters, and allow them to carry out alterations and extensions.

In one such case the circuit breakers between the alternator and the bus-bars and the fuses on the heaviest power circuit, kept operating, so the promoted engine tenter in charge removed them and bridged the gaps with copper links. No one questioned his action or imagined for one moment that they had been provided in the first instance to serve some specific purpose. Similarly, earthing conductors have been removed. Although millwrights and engine tenters may be qualifid to carry out routine operation duties, they have not the knowledge necessary for the detection and rectification of faults, and hence when cut-outs continue to operate on account of faults they are faced with the alternatives of either removing or making inoperative the protective devices provided, or asking for technical assistance. Frequently they choose the former alternative and carry on until a catastrophe of greater or less importance occurs.

Kinemas and Eyesight.

In the latter part of 1920 there were numerous references in the Press to cases of inflammation of the eyes of kinema actors attributed to exposure to very powerful lights at close quarters, and the matter received attention at a discussion of the Illuminating Engineering Society held in the early part of this year. It was then mentioned that a committee working under the Ministry of Health was investigating the matter.

The report of this committee, which received the assistance of several eminent ophthalmologists, including Mr. J. H. Parsons, the President of the Illuminating Engineering Society, is now available. Cases of eye-trouble, of a kind familiar to those who have handled powerful arc-lights at close quarters, are reported by Sir Anderson Critchett and others, but it is reassuring to note that the injuries have in general been of a transient character, and that no evidence of serious and permanent injury has been recorded.

The complaints received nearly all date from the last three months of 1920 and appear to be due to the injudicious use of very powerful arc lamps of the searchlight pattern, (largely imported from America), these having been employed without proper precautions as regards shading. Apparently injuries to the eyes in kinema studios were practically unknown before these prejudicial methods were introduced. Apart from the intense light produced, unscreened arc lamps are liable to cause injury owing to the access of ultra-violent rays. Fortunately the evidence of experts in kinema photographic work supports the view that these unscreened lamps are not necessary to film production, and that better results can be obtained when suitable diffusing screens are used.

A remarkable confirmation of this is afforded by the guarantee of the Incorporated Association of Kinematograph Manufacturers that in future no open-arc lights will be used for general illumination in their studios without glass filters.

Now that the evil has been recognised and a lead has been given by the leading manufacturers of films, I hope that little further trouble will ensue. The committee, however, remark that the industry is in a state of development, and welcome the statement of Mr. Leon Gaster that the Illuminating Engineering Society is forming a joint committee to study the question in detail. The services of the Society in this field should be useful alike to kinema actors and to the manufacturers of films, for there are doubtless many technical problems that remain to be solved in order that the British film industry may develop and prosper.

ELEKTRON.

THE ENGINEERING EXHIBITION.

PRELIMINARY NOTICE.

Wednesday next, the 7th inst., is the opening day of the Shipping, Engineering and Machinery Exhibition at Olympia. Over 300 exhibitors are combining to present one of the finest displays of shipbuilding and engineering ever witnessed, and it is to be hoped that this exhibition will very materially help to stimulate that trade revival which is so necessary to our well-being.

The railways are offering facilities in the form of special excursions, and we might remind manufacturers, traders and others that it is to their interest and to the benefit of the country as a whole that they should do everything possible to assist their foremen, staff, apprentices, etc., to visit this and similar displays.

Detailed reference to all exhibitors is impossible in the space at our command, but the exhibits of greatest electrical interest will be referred to in future issues of *Electricity*. We would, however, here draw attention to the following:—

At Stand No. 207 the British Thomson-Houston Co., Ltd., are showing in operation a portable master controller for cranes. To overcome the waste in fuel and in rivets by heating them in the ordinary way the B.T.H. Electric Rivet Heater has been designed. By its use it is assured that rivets will not be rendered useless by burning, scale, melting together, or by any other of the inevitable forms of defective heating. The B.T.H. Rivet Heater consists primarily of a portable, light, iron framework, which supports a compact air-cooled transformer, the primary of which is connected through a six-tap drum controller to the A.C. supply.

The secondary of the transformer is connected to two movable copper electrodes which can be raised or lowered by means of foot pedals so that rivets may be held between these electrodes and a fixed copper block extending below the two electrodes. The rivets are heated by placing them in a vertical position between the electrodes and the copper block; the whole of the heavy secondary current passing through the rivets in parallel. Six heats, from "low" to "high" can be allowed for by means of the drum controller on the primary of the transformer, to allow for various sizes of rivets or the rate of output required. This self-contained rivet heater will heat any size of rivet from ½ in. to 1¼ in. in diameter, and from 1 in. to 5 in. in length, without variation of adjustment. The supply is connected to the controller through a switch fuse on the machine, and the first rivet is heated a few seconds after closing the switch. No time is wasted in starting, and power is only used

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when actually heating rivets. Due to the fact that heat is so accurately and easily controlled and, also, that the rivets are open to view by the operator, the wastage due to badly heated rivets should be reduced to a minimum under any conditions of labour. The rivets, being free from the effects of the fuels usually employed, are clean and practically without scale; the heat being generated inside the rivet. There is no danger of "shock" because the maximum potential across the electrodes does not exceed 5 volts. Heated rivets can be produced at the rate of about 5 lb. per k.w. hour.

Other B.T.H. exhibits include motors, controllers, a pedal switch, automatic compensator, A.C. switch-gear, flow meters for steam, gas, air, water or oil, Fabroil noiseless pinions, a portable wireless receiver, various Mazda lamps, lighting fittings and Floodlight projectors. The wireless receiver is remarkable in that it is a complete unit, weighing only 20 lb., in a case measuring 13 in. by 14 in. by 5in., and it does not require an external aerial or other wires. All that is necessary with this instrument is to stand the box on a pivot on the detachable cover, connect the telephones, and by simple adjustment "tune" the apparatus to the vibrations of the passing wave. The signals are sufficiently loud to enable messages to be taken from stations in France and Germany, and the direction of origin of the signals is indicated by the instrument. The case contains a receiving coil, adjustable condenser, two receiving "valves" or vacuum bulbs, accumulator for heating the valve filaments, dry cell for the telephone circuits, two small transformers, and a hinged frame which carries a second coil. The accumulator for heating the valve filaments is of the "unspillable" type, and only requires recharging after running with the bulbs lit for about 7 hours.

At Stand No. 80, Siemens Bros. & Co., Ltd., are showing engine-room telegraphs, loud speaking telephones, a helm indicator, navigation lights indicator, look-out indicator, revolution indicator, water depth indicator, and other indicators for various purposes, including the Hamill flow meter, an instrument for measuring the rate of flow of petrol, oil, or similar liquids. It is simple in construction and is unaffected by varying pressure, head, size or conditions of pipes, vibration or gradient. It can be used for measuring the fuel consumption of petrol or Diesel engines, the flow of circulating water in cooling jackets, the flow of oil to turbine bearings, etc.

Wireless installations for ships are also in view as well as distance pyrometer and thermometer apparatus, cables and wires, Siemens world famed primary cells and batteries, and incandescent electric lamps.

At Stand No. L210, the Electric Heating Co. are showing electric laundry, tailoring and domestic irons and kettles, besides an entirely new electric stove for heating soldering irons. The London Electric Firm are exhibiting searchlights, mirrors, reduction gear, lamps, lowering gear, two and four pole dynamos, and motors of the most modern pattern, winches, current carrying cabledrums, and flexible couplings. The latter is a new invention (prov. patented). Non-engineering material is employed, the flexibility being obtained by laminated steel, giving perfect elasticity over a wide range with absolute reliability under all conditions of working.

FACTORY LIGHTING.

The report of H.M. Chief Inspector of Factories for 1920, now issued, comprises an introductory general section and twelve chapters devoted to various aspects of factory development. One of these, by Miss R. E. Squire, deals with lighting. It is satisfactory to find that both managers and employees show increasing appreciation of the benefits of good lighting, but there are still many reports of inadequate conditions. For instance, glare from gas-filled lamps, due to neglect of shading, is still frequent, and window panes are often allowed to get into a sorry condition of dirt —so much so that occasionally work is done practically continuously under artificial light. Opinions about conditions in the shipbuilding industry seem to differ. Some reports

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OLYMPIA
7th September—28th September, 1921.

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infer that lighting conditions have much improved and that complaints of inadequate lighting are rare. It is, however, elsewhere mentioned that foremen are reluctant to introduce their sons at an early age owing to the danger of accidents, especially at night!

Reference is also made in several places in the Report to the important Safety Conference arranged in co-operation with the British Industrial Safety First Association at Olympia last September, the proceedings of which are available in pamphlet form. It is also interesting to note that the Departmental Committee on Lighting in Factories and Workshops has resumed its labours and is assisting in the preparation of a pamphlet dealing with the essentials of good industrial lighting.

The Departmental (H.O). Committee on Lighting in Factories and Workshops, referred to above, has presented its second report. As regards artificial light, dealing with glare, shadow and constancy, it is recommended that statutory forces be given to the following provisions:—

(A) "Every light source (except one of low brightness) within a distance of 100 feet from any person employed shall be so shaded from such person that no filament, mantle or frame is distinguishable through the shade, unless it be so placed that the angle between the line from the eye to an unshaded part of a source and a horizontal plane is not less than 20 deg., or in the case of any person employed at a distance of 6 feet or less from the source, not less than 30 deg."

Low brightness means an intrinsic brilliance of not more than 5 candles per sq. in.

(B) "Adequate means shall be taken, either by suitable placing or screening of the light sources, or by some other effective method, to prevent direct reflection of the light from a smooth or polished surface into the eyes of the worker."

(C) "Adequate means shall be taken to prevent the formation of shadows which interfere with the safety or efficiency of any person employed."

(D) "No light sources which flicker or undergo abrupt changes in candle-power in such manner as to interfere with the safety or efficiency of any person employed shall be used for illumination of a factory or workshop."

(E) "That, as regards existing installations, a reasonable time limit should be given before the above requirements become operative."

The Report is published by H.M. Stationery Office. Price 1d.

METROPOLITAN-VICKERS OIL CIRCUIT BREAKERS.

A series of three "circulars," Nos. 1254/1, 1266/1, and 1266/2, issued by the Metropolitan-Vickers' Electrical Co., Ltd., deal extensively with the breaking capacity of oil switches and circuit breakers. The first circular is a reprint of an article by Mr. W. A. Coates in the *M.-V. Gazette*. Mr. Coates points out that in determining breaking capacity figures wide experience is essential, and states that the M.-V. Co. are in an unique position in this respect, since they have full access to the technical data accumulated by the Westinghouse E. and M. Co. in America, and by Brown, Boveri, in Switzerland, in addition to that derived from their own products. Illustrations are given of the largest oil circuit breaker yet built—type G2. It is made for 115,000 volts, 135,000 volts and 155,000 volts, and normal current of 400 amp. at 50 cycles.

A quadruple butt contact is employed in conjunction with a special form of quick-break device, which parts contact only after the main contacts have separated some six or seven inches. The successive stages of the opening movement are shown in detail in the second circular. Such a device is desirable with very large switches such as these, in order to ensure that the moving element has attained a high velocity before drawing an arc. Each contact plunger has its own spring, and flexible braided copper is used to connect the plunger to the main contact block, and thus prevent current passing through the springs. A protecting shield is fitted over the lower end of the condenser terminal to protect it from damage due to the arc when opening circuit. The moving contact arm is suspended from a micarta rod of tubular section, which at the upper end moves through a micarta guide. This provides a construction which is perfect, electrically and mechanically. The contacts are enclosed within shields of perfectly smooth profile in order to remove any chance of corona discharge being started from the unavoidable corners and edges of the contacts themselves. The greatest care is taken in every detail to get perfectly rounded faces.

Another high voltage type (G 11) is described and illustrated in the third circular. The effect of altitude on the rating is discussed.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 124.

How would you find the direction of phase rotation on 2- and 3-phase systems? Is it possible to determine the direction of rotation of induction motors before switching on the current?—"S. H. ADAMS."

QUESTION No. 125.

How would you calculate the number of turns in the stator windings of an induction motor? It is presumed that a few of the factors are known, such as:—speed, voltage, frequency, etc.—"S. H. ADAMS."

(Replies to questions Nos. 124 and 125 must be received not later than September 24, 1921.)

Answers to Correspondents.

BOOK BUYER.—Yes, technical books are still very expensive, and this is a fact which is much to be regretted because it is an absolute handicap on technical education, and more particularly so to the sons of those who cannot afford the high prices which are necessitated by the heavy cost of production. However, quite a respectable amount of work is now being sent to Holland, where the charges are much lower and the work can be produced in English type characters, and revised on this side, so that in course of time the cost of books should come down. That is, unfortunately, a loss of work to the members of the trade unions on this side, but evidently they are anxious to be generous to their friends in Holland. It is the only interpretation which can be placed on their action.

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ELECTRICAL EQUIPMENT OF S.S. "BARADINE."

The s.s. "Baradine," a twin-screw passenger steamer, built to the order of the Peninsular and Oriental Steam Navigation Company by Harland and Wolff, Ltd., for their branch line service between London and Australia, left the port on the 18th ult., after undergoing successful trials in Belfast Lough. The principal dimensions are—length 537 ft., breadth 64 ft., and depth 41 ft., with a gross tonnage of about 13,300. The new vessel, which is classed 100 A1 at Lloyd's, has accommodation for about 500 cabin passengers, and provision can be made on the main deck to take nearly 1,000 third class passengers.

There is a very complete electrical installation, consisting of four main generators, in addition to which there is a vertical oil engine driving a dynamo. The watertight doors are all operated and controlled electrically from the captain's bridge. There are two electrically-operated lifts for the pantry, and among the service machinery there is electrically-driven apparatus for mixing the dough, washing dishes, and peeling potatoes. The ship's whistle is automatically operated electrically from the captain's bridge. Among the other electrically-driven gear is included large forced draught fans for the boilers, refrigerating fans and the ventilation fans throughout the vessel. Special attention has been given to the ventilation, so as to give the maximum comfort to passengers in hot weather. Loud-speaking telephones are available to assist in the navigation of the ship, and there are considerably over 1,000 lights installed, and over 70 motors.

"LIFTS."

Under the above title, Marryat and Scott, Ltd. (28, Hatton Garden, E.C.1), have published a work unique of its kind. The various parts of passenger and goods lifts are described and the pros and cons of alternative design fully discussed, so that an engineer or architect, or anyone for that matter who will take the trouble, may specify what he requires with knowledge. The text is freely illustrated with diagrams and photographs of actual apparatus together with typical examples of complete lifts.

The general lay-out of a new lift is dealt with in such a way as will greatly assist anyone scheming out the plan of a new building. A lengthy chapter upon the choice of position for the winding engine advances entirely new arguments on the debated question whether the gear should be at the top of the lift shaft or in the basement, whilst another dealing with enclosures, doors and gates will be found to be specially instructive.

The various methods of setting out a lift well showing the numerous possible combinations of wood and steel guide fixings form the subject of a page diagram from which may be readily deduced the maximum inside dimensions of car for any given well size and guide arrangement and *vice versa* the necessary dimensions of well for any given car size.

The chapters on estimating should prove of assistance to the firms' own staff and country agents, and will be invaluable to agents and correspondents abroad. An ingenious feature of the price-tables is the use of the current market rate for raw material as a basis, so that with a knowledge of the market price say for round steel bars the list prices of steel guides can be adjusted from day to day if necessary, over a wide range of fluctuations.

Another feature of the list is the excellent coding system employed. Whilst exceedingly simple; it will enable the most minute instructions to be transmitted in the briefest possible form.

As regards automatic control, *i.e.*, the push button control system on which the majority of lifts are now operated, a feature of the Marryat-Scott controller is that should two separate pushes be operated exactly at the same time the car will travel to the farthest point of call in the direction of its previous travel. No amount of simultaneous calls can cause any derangement.

The complete equipment for Automatic control comprises one Push-button Tablet for car, one Push-button for each floor, one Direction Switch for each floor, one Relay Panel, one Control Panel, one Rheostat, One Safety Gate Lock for each floor, one Main Limit Switch, and two Half-way Connection Boxes. Space limitations prevent detailed reference to all the components, but the following should be noted:—Direction and floor levelling switches, relay panel, control panel.

The Direction and Floor Levelling Switches (Fig. 1) are fixed in the lift-well, one at the level of each floor. They are operated by means of a cast aluminium ramp of special design, which is attached to the side of the car. One of the functions of these switches is to control the direction in which the car shall travel. Thus, if the car be at the top of a six-floor building, and the third-floor push be



FIG. 1.—DIRECTION AND FLOOR-LEVELLING SWITCH. A—2 in. B—15 in.

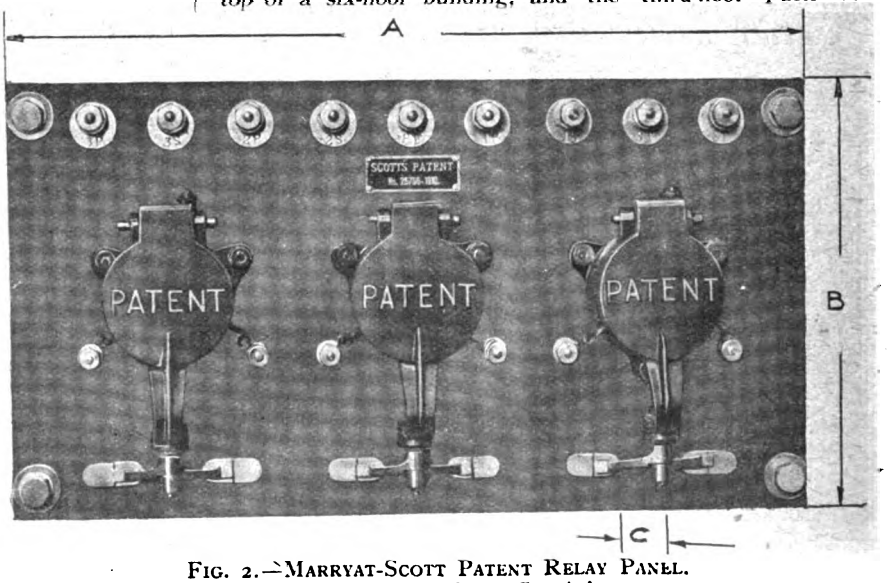


FIG. 2.—MARRYAT-SCOTT PATENT RELAY PANEL. A—17 in. B—9¼ in. C—4½ in.

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operated, it will travel down, whereas if the car were at the bottom of the well, pressure on the same push would cause it to travel up.

It is also by means of floor switches that the accurate floor levelling, independent of rope stretching, which is a feature of this system, is secured. Manufacturers and others who handle goods in trucks will at once appreciate the importance of this feature, which is also a consideration in all places used by the general public. In the hospital for bed and ambulance work, accuracy of floor levelling is sufficient alone to place these lifts in a category apart from others.

The Direction Switches are totally enclosed in cast enamalled iron cases with a special ingress slot for the attachment of screwed conduit. Silence in operation is assured by the gun-metal bushed rubber roller, which can be adjusted axially, and comes in contact with the aluminium ramp.

The Relay Panel (Fig. 2) contains as many relay magnets as there are floors. These may be mounted each on a separate base or together on one. These relays act instantaneously and sparklessly. Provision is made on the relay panel for interlocking and arresting the push-button circuits, so making it impossible for any lift operated upon this system to be set in motion until all the gates or doors are closed. The connections are such as to make it impossible for any push-button to be operative until a journey already commenced has been completed.

The Control Panel (Fig. 3), as its name implies, is the central and most important part of the control gear. This panel receives its instructions, as it were, from the push-buttons through the direction switches and relays, and causes the motor to start, stop, and reverse accordingly.

It will be seen that there is a complete absence of small parts and contacts. It consists essentially of two magnets mounted upon a polished slate panel which can be bolted direct to the wall of the motor-room by means of the universal cast iron feet provided.

An examination of the key diagram (Fig. 4) in which S.=The solenoid-operated main switch, R.=Solenoid-operated reversing switch, A.=Motor armature, F.=Motor shunt field, RC.=Starting resistance, shows (1) its simplicity; (2) the excellent provision made for discharge of the motor shunt field, avoiding, at the same time, any danger from disruptive discharge and the necessity for a non-inductive resistance to protect the windings.

With this simple controller, which is fully covered by patents, results which have not hitherto been accomplished even with the aid of much complication and many parts, are obtained.

The Control Panel comprises a *Reversing Switch* for selecting the direction of rotation of the motor, and an electro-magnetic *Master Switch* which opens the main circuit under the influence of a powerful magnetic blowout. The connections are such that the field coils of the motor are protected from breakdown due to self-induction by connecting them permanently in parallel with the armature circuit. Further, it is impossible to cause the lift to move except in the way it is intended to do, and no possible combination of accidents to switches, contacts, or other parts of the lift can do more than cause a temporary stoppage.

It is of the utmost importance with automatic lifts that the gate-locking devices should be such as to prevent the possibility of accident.

In principle, the Marryat-Scott lock consists of a mechanical latch which is released by a cam attached to the car, and can therefore only be free to open when the car is in position opposite to the lock. An electrical contact within the lock is so arranged that when the gate is opened the control circuit is interrupted and all push-buttons are inoperative. Closing the gate allows control to be regained, and immediately the lift is in motion the gate is mechanically locked. Adaptations have been standardised for employment with double collapsible gates, single doors, double doors, and for shutters such as are used with service lifts.

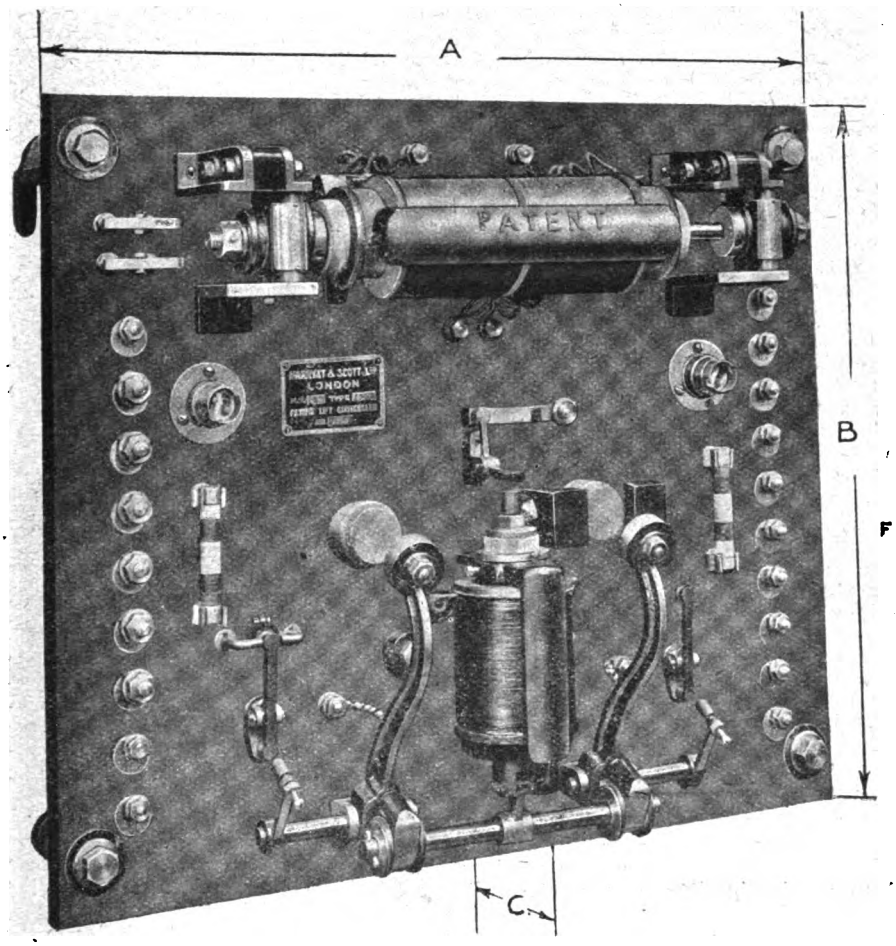


FIG. 3.—MARRYAT-SCOTT PATENT CONTROL PANEL.
A—24 in. B—21 in. C—7 in.

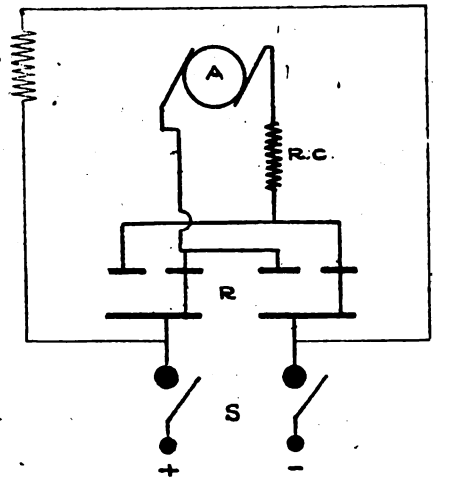


FIG. 4.—KEY DIAGRAM OF CONTROL PANEL.

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QUICK MAKE AND BREAK TUMBLER SWITCHES.

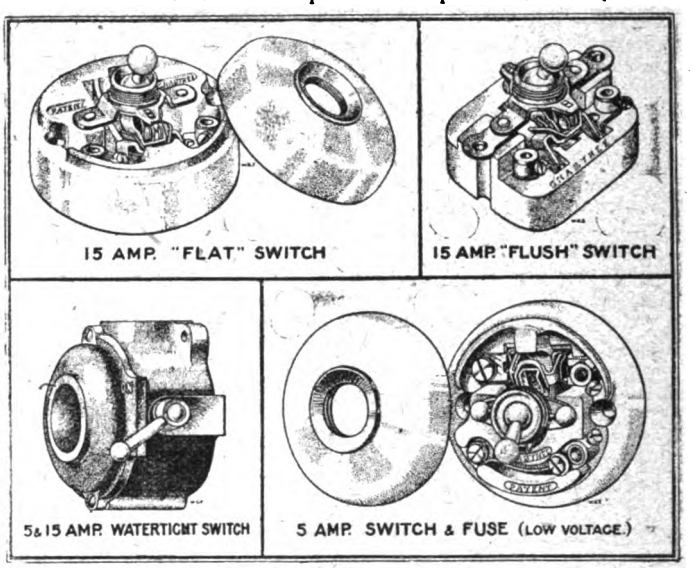
The tumbler switch has many points in its favour. It is convenient to operate, is more artistic than the rotary type of switch, and offers possibilities for substantial construction and equal reliability with the rotary type. Heating and cooking apparatus, as well as small motors and gas-filled lamps, etc., all have relatively heavy or heavy instantaneous currents to control, with the result that the slow make pattern of tumbler is not suitable. English practice has, however, generally been content to retain the slow make pattern, excepting where the American or Continental quick make and break rotary switches offer such inherent advantages, as on large cookers, that there is no alternative. As regards the more exacting demands of present-day lighting, tumbler switches as a class perhaps still follow the general design of twenty years ago, with the result that the rated capacity is sometimes merely of nominal value, it being well known that many so called 5 amp. switches are not suitable for 5 amp. circuits. The diameter of the base of itself gives no real indication regarding the capacity of the switch. Gas-filled lamps have accelerated the growing demand for tumbler switches with a "snap" action. The reason for this may be appreciated from the study of oscillograph records, *e.g.*, an oscillographic record of the current flowing on the switching on of a gas-filled lamp circuit shows that a circuit having a normal capacity of 6.6 amps. has an initial rush of current of 39 amps. at the moment of switching on. This surge of current falls immediately, but a fifth of a second elapses before it drops to normal. It will therefore be obvious that, unless a switch makes practically instantaneous contact, there is a very heavy rush of current on the infinitesimal surface at first making contact.

A most suitable form of tumbler switch to withstand such a surge is made by J. A. Crabtree and Co., Ltd., of Walsall, who also manufacture two-way switches with a quick break on both sides. These switches, which we have examined, are of excellent workmanship and material throughout. Further, they have extreme simplicity of action and are unaffected by vibration. The movement consists of a handle and switch arm, both of which rock on a phosphor bronze pin, being interconnected with the necessary spring mechanism. The contact clips of hard copper are well sunk into the base, and are so designed that the parts giving a spring contact are remote from the arcing tips, thus avoiding any chance of the arc softening the clips. The springs are of steel, electro-tinned, and of the spiral compression type—supported on a central telescopic pin.

Apropos of this, we are advised that interesting tests have been carried out in comparison with the ordinary flat switch spring with the following result:—While on test the ordinary flat switch springs collapsed at from 20 to 50,000 operations—the "Crabtree" compression springs after being operated three million times had still good life. To demonstrate the rapid operation of the contacts a cinematograph film was taken at a speed of 200 exposures per second, the actual time of each exposure being slightly over .0011 sec. When the film is shown on the screen at the ordinary projection speed, the movement of the hand in throwing over the switch is slowed down to a crawl. The switch movement, however, is seen as though instantaneous in action. An examination of the actual film shows that the throw-over of the switch is so extremely rapid that there is only one exposure between the switch starting to throw over and completing contact.

Similar tests made on ordinary slow make flat switches of the link pattern, switching "on" and "off" in half a second, we are informed, show that it takes one-tenth of a second to make full contact.

Reverting to the oscillograph referred to previously, it is obvious that, while the "Crabtree" Quick Make and Break Switch makes practically instantaneous contact in order to carry the full rush of current of 39 amps., an ordinary type of switch is compelled to carry the whole of the current surge on a very small contact area. In fact, this type of switch does not make complete contact until the current surge has almost fallen back to normal. An analysis of the action of a slow make switch shows that there is a "dwell" for a distinct period of time, with the contact arm resting at the point of first making contact. Any looseness in the mechanism exaggerates this "dwell." It is at this position of point contact that the greatest damage is done, and arcing first set up. Every successive "switch on" increases the damage, and a very few operations will burn out the switch, on circuits considerably below its rated capacity.



Some examples of "Crabtree" switches are shown in the illustration herewith.

CARRIER CURRENT TELEPHONY AND TELEGRAPHY.

(*Continued from page* 475.)

Lines.—The electrical design of carrier systems is determined in large part by the problems which arise in the transmission of the carrier currents over the line wires. The comparatively high frequencies used in carrier transmission attenuate much more rapidly in passing along the lines, have a much greater tendency to cause interference in adjacent circuits than do the ordinary telephone frequencies. Both attenuation and interference increase rapidly with increase in frequency. Because of this it has been found most economical to make use of the frequency range commencing immediately above the voice range. The systems which have so far been put into commercial use employ frequencies up to about 30,000 cycles.

Because of the high attenuation and interference, carrier transmission is particularly dependent on the use in the circuit of repeaters placed at comparatively frequent intervals. To indicate the importance of repeaters it is interesting to note that if the Harrisburg-Chicago carrier telephone system, which spans about 750 miles, were operated without repeaters, it would be necessary under the most favourable line conditions to apply at the sending end of the highest-frequency channel a power of 60 kilowatts. By the use of intermediate repeaters the high-frequency power at no point exceeds 0.1 watt.

Some of the experimenters in this art have had the misconception that the mode of transmission of the high frequencies employed in carrier operation was different from that of the ordinary telephone frequencies, and that the carrier frequencies had some unexplained property whereby, although guided by the line wires, large energy losses in the line wires were avoided. There is, however no theoretical or experimental basis for this idea. As a matter of fact,

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the line attenuation of carrier currents is considerably greater than for telephone frequencies and increases rapidly with frequency, due to the increased resistance of the line wires, and increased effective leakage between the line wires at the carrier frequencies. While it is, of course, proper to picture the mechanism of carrier transmission as one in which the energy is contained in the electromagnetic waves, which are guided by the line wires, this is no less true for the transmission of low frequencies. The difference between radio and wire transmission, whether of high or low frequency, is the difference between unguided and guided waves.

Cable.—Transmission over cables will be discussed here in connection with the unavoidable use of short lengths of cable in open wire lines, for toll entrance in bringing the circuits into the central offices, at river crossings, in passing through cities, etc. Such lengths of cable have two effects:

(*a.*) They introduce a considerable transmission loss due to the inefficiency of cable circuits at these higher frequencies; and

(*b.*) They introduce a large irregularity in impedance characteristics which, in systems depending on balance for duplex operation, affects radically the amount of amplification which may be obtained at repeater points.

To reduce both the attenuation of the circuits at these frequencies and the impedance irregularity which short lengths of cable introduce, there has been developed a system of coil inductance loading.

Loading for Carrier Frequencies.—The loading systems which have been developed for cable are adapted to transmit frequencies up to about 30,000 cycles. The coils are spaced about 1,000 feet apart and the inductance is chosen so as to give the cable circuits the same characteristic impedance as the lines to which they are connected. The decrease in irregularity in impedance as the frequency increases is due to the fact that the attenuation increases with frequency, so that the cable, for instance, at Altoona, is electrically further away at the higher frequencies. Since, however, the large attenuation has to be made up by larger repeater gains, the smaller apparent irregularity at the higher frequencies is of equal or greater practical importance than that at low frequencies. It will be noted, furthermore, that the loading largely overcomes the effect of the two lengths of cable. The slight remaining reactance component, which occurs at the higher frequencies, is largely due to the office wiring at the end where the measurements were made; and the slight remaining irregularity is due to some office wiring at Altoona.

Under some conditions it has been found convenient to leave lengths of cable in carrier systems unloaded, and to install auto-transformers between the cable and the open wire circuits to reduce the reflection losses introduced by the cables.

Line Balancing for Two-Way Operation.—As already pointed out, two-way operation may be carried out either by the use of different frequencies in the two directions, or by using the same frequency for the two directions but using duplex balancing arrangements at the terminals. When different frequencies are used in the two directions it is sometimes convenient to employ line balance to supplement the selective circuits. A balance can be obtained by employing an artificial line consisting simply of a non-inductive resistance of about 600 ohms. Moreover, this resistance gives a good balance for all of the channels employed in a carrier system.

For systems requiring it, balance must be obtained not only at intermediate repeater points, but also at each terminal, since the terminal set is itself inherently a repeater.

There has already been pointed out the manner in which irregularities due to intermediate lengths of cable are cared for by loading. It is important that lines used for carrier operation shall be kept as free as possible from intermediate lengths of cable, lengths of twisted pair, etc.

Interference Between Circuits—Transposition.—Any general use of carrier systems in the telephone plant requires that it be possible to operate a number of similar systems over the same pole line without mutual interference, that is, to transmit the same range of carrier frequencies over a number of circuits running closely together on the same line, with only negligible interference between channels of different carrier systems.

Inasmuch as the only means available for preventing interference between circuits where the same carrier frequency is employed in both directions is that of balance between circuits, effected by transpositions, it is obvious that where a number of carrier systems are to be operated on the same pole line, the circuits must be operated on the metallic and not on the ground return basis. Metallic circuits are also desirable for reducing foreign high-frequency interference, such as "static" and that from high-power radio stations employing frequencies in the carriage range.

The transpositions existing in open wire telephone circuits are generally inadequate to balance the circuits sufficiently accurately for the higher frequencies of carrier transmission.

As a result of a considerable amount of line measurements of the above types with different transposition systems, and from theoretical investigation of cross-talk at these frequencies, it has been determined that the interference limitations are roughly as follows:

Where carrier systems employ the same frequencies for transmission in the two directions, it would not be practicable to operate systems on all the pairs of a line, since the number of transpositions required would be prohibitively large. In fact, in a lead carrying a considerable number of circuits, the transpositions would have to be more closely spaced than are the poles under present standard construction. It is possible, however, to reduce greatly the effect of interference between circuits, by employing systems using different frequencies in the two directions, and arranging so that all of the systems employ the same range of frequencies in each direction. This reduces, of course, the number of two-way channels which may be obtained per pair. It is not certain, however, that even with this arrangement of carrier systems it would be economical to apply carrier to all pairs of a pole line.

Much has already been accomplished, however, in transposing a limited number of pairs on a pole line for carrier operation, and this constitutes the practical problem in most of the present cases; for example, two carrier telephone systems and one carrier telegraph system are operating over the same pole line in the section of the New York-Chicago line between Harrisburg and Pittsburg, a distance of about 200 miles. While the circuits involved in this case are not adjacent on the cross-arm, the systems employ the same frequencies for transmission in opposite directions, and therefore represent a severe condition as regards interference.

Noise Interference.—As the frequencies used in carrier systems are considerably higher than the harmonics which are generally present in power systems, these circuits are less subject to noise from power interference than are the ordinary telephone circuits. They are not free from such interference, however, since high frequencies may be set up in power systems by the charging of lighting protectors, switching, etc. Since the circuits cannot in general be as well balanced to ground at carrier frequencies as at ordinary telephone frequencies, the carrier channels have shown a certain amount of interference from atmospheric electrical effects—that is, so called static. Some interference has also been experienced from high-power long-distance radio systems which are now employing frequencies within the same range.

Line-Measuring Apparatus.—To put the lines in proper shape for carrier operation and to maintain them properly has necessitated the development of a suitable measuring technique and of portable measuring units, including a high-frequency oscillator, high-frequency impedance bridge, detector circuits, thermo-couples, etc.

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A portable high-frequency oscillator designed for testing work involves the use of four vacuum tubes and affords stable outputs as high as 500 milliamperes into an average line impedance. Its frequency range extends from 100 cycles to 50 kilocycles, and it is designed to operate on telephone-office power-supply sources.

Attenuation measurements have been carried out largely by the use of thermocouple meter circuits in conjunction with an oscillator of the general type. This permits measuring directly the attenuations of lines up to about 250 miles in length. The current sent into the line is compared with the corresponding received current, with the circuit properly terminated. An over-all accuracy of about 1 per cent. is usually obtained. Current as low as 0.25 milliampere may be read with this method, thus making it possible to measure attenuations involving current ratios up to 1,200, or a line length equivalent to approximately 50 miles of standard cable. For greater lengths of line, circuits involving the use of the sensitive detector circuit have been employed using comparison methods.

Impedance measurements are made with the oscillator, bridge and detector circuits.

(To be continued.)

RECTIFIERS FOR THE "CHEMINS DE FER DU MIDI."

An interesting application of mercury arc rectifiers is to be found in the electrification of the above railway, the Societe Anonyme Brown Boveri et Cie. (the Swiss House of Power-Rectifiers, Ltd., Trafalgar House, Waterloo Place, S.W.1), having recently secured an important contract for the complete equipment of the five sub-stations of Pau, Lourdes, Tarbes, Montrejeau and Lannemezan.

The contract comprises in all sixteen 1,200 kw. rectifier sets to operate at a D.C. pressure of 1.575 volts. Each set consists of a single main transformer supplying two H.T. rectifiers in parallel. The primary supply will be three-phase at 60,000 volts, and a periodicity of 50 cycles. Everything from the H.T. to the D.C. side is included in the contract. The overload capacity for which the rectifiers are being designed is 50 per cent. for two hours and 200 per cent. for five minutes.

The progress made during recent years with this class of plant is very marked, the company informing us that something like 160 individual equipments are being either installed or in hand. They comprise roughly 340 separate rectifiers, giving a total capacity of about 100,000 kw.

Trade Notes.

The Edison Swan Electric Co., Ltd. (Ponders End, Middlesex), have now issued a complete catalogue dealing with the Ediswan house-wiring system described in ELECTRICITY for July 29. Included in the catalogue are suitable lampholders, ceiling roses, switches, cut-outs, fuse-boards, etc., as well as Rawl-plugs.

The Jackson Electric Stove Co., Ltd. (143, Sloane Street, S.W.1), have appointed as their agent for the whole of Scotland, Mr. H. L. Kirby Johnson, of 68, Gordon Road, Glasgow. As their agent for the Midlands they have appointed Mr. Kenneth Hoggan, of Needless Alley, New Street, Birmingham. A range of samples and small stocks will be held in both cases.

A series of attractive leaflets for enclosure with statements, receipts, etc., has been produced by **Belling & Co.** (Derby Road, Edmonton). Each leaflet deals with one item of the company's manufactures from the popular point of view and can be overprinted with the name and address of the dealer, supplier, contractor, or supply authority. The items dealt with include the Belling hot-plate, warming disc, boiling plate, table cooker, cookerette, electric iron, etc.

Circular No. 1790-1, issued by the **Metropolitan-Vickers Electrical Co., Ltd.** (Trafford Park, Manchester), gives a list of the particulars required to enable the company to work out propositions for the electrification of rolling mills. The detailed information in the circular further shows that, since 1906, the M.-V. Company have installed 322,500 peak h.p. for rolling mill drive, the number of installations being 183 continuous mills, and 14 reversing. The average normal h.p. is 460 and 3,415 respectively.

Various Items.

Brazil.—In connection with the celebration of the Centenary of Independence at Rio de Janeiro an extensive National and International Exhibition is to be held in the autumn of next year.

Blackpool.—Mr. R. Barron, electrical engineer, of Albert Street, Blackpool, has secured the contract for wiring the new secondary school, off Poulton Road. A large number of firms tendered.

Johannesburg.—The Rand Water Board require tenders by Nov. 7, for two steam-driven generators of 350— kw. capacity each, complete with switchboards and accessories. Particulars and copy of specification, etc., D.O.T.

New Zealand.—The P.W.D. requires tenders for three water-wheels of 6,450 b.h.p. each, two of 3,225 b.h.p., alternators for same, exciter sets, transformers, insulators and lighting accessories, etc., by November 29. Particulars from Inquiry Room, D.O.T.

The "Wileroid."—We were pleased to receive a short time ago the July issue of the *Wileroid*, which is a bright, humorous illustrated periodical published by the Willesden Works Employees of the British Thomson-Houston Co., Ltd. We enjoyed the issue very much and hope that the *Wileroid* will receive the support it deserves.

Marconi's W.T. Co.—The report for the year ending Dec. 31, 1920, has just been published—the annual general meeting being held last Wednesday week. Total dividends for the year are recommended as follows:—Preference shares, 12 per cent.; Ordinary shares, 15 per cent. £820,567 is carried forward. Owing to the unfavourable exchange rates much of the money due from abroad has been left there on deposit.

Belgium.—The Ministry of National Defence have invited tenders for the supply of 23 wireless telegraph and telephone installations required by the Artillery Dept. Tenders, which should be addressed to the Minister of National Defence (3e Direction Generale), 10, Rue du Meridion, Brussels, will be received up to 10 a.m. on the 14th inst. Copies of the specifications, etc., may be inspected on application to the Inquiry Room, D.O.T.

A Food Exhibition.—A Food Exhibition is being organised for Olympia, London, in Sept., 1922. Besides food stuffs, their preparation and distribution, working machinery, refrigerating plant, cooking utensils, demonstrations of cookery, model factories, etc., will find place. The joint organising bodies are the International Trade Exhibitions, Ltd., and the Trades' Markets and Exhibitions, Ltd. The offices are at Broad Street House, New Broad St., E.C.2.

F. T. C. Old Students' Assocn.—The annual general meeting is to be held at the Finsbury Technical College on Monday next, the 5th inst., at 6 p.m., to consider the financial statement for the period April 30, 1914, to December 31, 1920—this has just been published, and reveals a practical balance of income and expenditure with the aid of grants from the City Guilds of £40—the year's progress, propaganda work and "general business." The Hon. Sec. is H. P. Guy (209, Northumberland Park, Tottenham, N.17).

"Model Engineer" Exhibition.—The fifth *Model Engineer* exhibition is to be held in the Hall of the Royal Horticultural Society (Vincent Square, Westminster), in January next year. As in the previous exhibitions, the exhibits will embrace small power plants, tools, engineering models, electrical appliances, scientific instruments, technical education, etc., while the usual facilities for refreshment and comfort will be provided by the organisers—Percival Marshall & Co., of 66, Farringdon Street, E.C.4.

Bournemouth.—Mr. E. Brontman, R.T.E.E. (electrical engineer and contractor, 139, Bournemouth Road, Parkstone, Dorset), is arranging a lecture and demonstration in St. Peter's Hall, Bournemouth, on Oct. 5, at 3 p.m. Already sufficient support is promised to enable the industry in the town to benefit considerably. The following firms are among those participating:—Belling and Co., Falkirk Iron Co., Ltd., Berry's Electric, Ltd., the Ediswan Co., Ltd., Simpson Baker and Co., J. and W. B. Smith, Ltd. The Marconi Scientific Instrument Co., Ltd., have loaned their M15 receiver, and are arranging for a Loud Speaker, so that a "wireless" concert can be provided.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
SEPTEMBER 9, 1921.

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THE PROPERTIES OF INSULATORS.

By G. W. Stubbings.

The majority of known substances can be divided into two well-defined classes, with regard to their electrical conductivity—those which conduct freely, this class comprising the substances which are known chemically as metals—and those whose conductivity is exceedingly small, this class comprising the vast majority of non-metallic substances. There is a third class with conducting power between the first two, this comprising substances known as electrolytes. The most familiar examples of electrolytes are aqueous solutions of acids and metallic salts. The mechanism of conduction in electrolytes is, however, quite different from that in metallic conductors, as in electrolytes the transfer of electricity is effected by the movement of electrified ions, or particles of molecular size, whilst in metallic conduction the transfer of electricity is not associated with any movement of molecular masses, but with successive exchanges of electrons.

Non-conductors of electricity are usually known as insulators, and are extensively used in order that the flow of electricity may be, as it were, restricted to a given path. The electrical properties of such substances are then of great importance, and it is noteworthy that, whereas in the case of conducting substances their conducting power is the only electrical property that it is requisite to know with certainty, there are three electrical properties of insulators which are of similar importance, and which are, as far as is at present known, quite independent each of the others.

The first of these properties is the actual conductivity, or the insulativity as it is more conveniently designated. It is remarkable what an exceedingly wide difference there is between the conductivity of even a high resistance metal, and that of a true insulator. The specific resistance per centimeter cube of bismuth, for instance, is about 120×10^{-6} ohms, whilst the similar electrical constant for, say, ebonite, is 2×10^{15}. The ratio of the conductivities of these two substances is then no less than 1.7×10^{-19}.

The number of substances that are nearly perfect insulators is large, and this circumstance undoubtedly has been of great importance in the commercial development of electricity. The insulativity of non-homogeneous substances—especially those of a fibrous nature—is well-known to be greatly impaired by the presence of moisture. It is to be noted that this is not due to the high conductivity of water itself. Actually pure water is an excellent insulator, having a specific resistance of no less than 7×10^{-12} ohms. Water is, however, unique in forming solutions with even minute quantities of solid matter which have a high electrolytic conductivity. And there is little doubt that the conductivity of damp insulators is of an electrolytic nature. The importance of guarding against the access of moisture is well exemplified by modern practice in the manufacture of underground cables.

The conductivity of all insulators is increased by heat, and in some cases the increase is very rapid. Underground cables when laid on the solid system will show an exceedingly low test, if this be taken before the bitumen filling has cooled. At high temperatures most insulators conduct freely and the conduction is of an electrolytic nature.

The second property of insulators that is of importance from an electrical standpoint is the specific inductive capacity, or the dielectric constant. This figure is the ratio of the capacity of a condenser having the material in question for an insulator to that of a similar condenser insulated with air. The nature of the dielectric constant is best understood by considering what happens when a high voltage is applied to a condenser of simple form—such as a sheet of glass covered on each side with tin-foil. If the glass were a conductor a current would pass. The properties of glass being that of an excellent insulator, the permanent current will be of infinitesimal amount, but the application of the voltage will set up a state of stress in the glass, and a transient current will pass. If the pressure is removed and the condenser discharged a quantity of electricity will be obtained which is almost exactly equal to that taken by the charge. The glass can be likened then to a kind of spring buffer between the two conducting plates in which a strain is set up and in which energy is stored by the application of electrical pressure. The dielectric constant is a measure of the "yield" of the insulator, as this "yield" or "give" obviously is the cause of the charging. A material such as air with a low dielectric constant can be likened to a substance of high elasticity, or to a stiff spring, while such a material as flint-glass, with a dielectric constant of nearly 10, can be considered as having an electrical springiness of only 1-10th that of air.

When dielectrics are subjected to rapidly alternating electrical pressures such as occur in E.H.T. alternating current working an effect is produced known as dielectric hysteresis. Dielectric hysteresis is a kind of molecular friction in the dielectric which causes heating, and the expenditure of energy when it is subjected to high alternating stresses. When a cable is connected to an alternating supply the power factor of the current flowing into it would be zero if the insulation were perfect. Actually there is a power component of the current, and, moreover, this component is greater than is accounted for by leakage. This is due to the loss occasioned by dielectric hysteresis, and this power loss increases as the square of the voltage. The loss due to dielectric

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hysteresis on a 33,000 volt cable of .2 section would be of the order 6 K.W. per mile. If this loss were due to leakage the insulation resistance of the cable would have to be as low as 0.2 meghom per mile.

The third property of insulators of great practical importance is that of dielectric strength. If the pressure applied to an insulator is continually increased, a point is reached when the insulator is no longer able to stand up to the stress, and, in ordinary language, it " breaks down." What precisely happens at breakdown to make the insulator a conductor is not known with certainty, but it is probable that, either due to mechanical stress or due to intense local heating, the material is converted to the ionised condition and the conduction is electrolytic in character. The dielectric strength of an insulator is measured in volts per millimeter, and it is to be noted that high insulation resistance is no indication of high dielectric strength. The insulation resistance, for instance, of dry air is practically infinite, but the dielectric strength is less than that of marble, the insulation resistance of which is as low as 5×10^8 per cm. cube. It may be remarked that the dielectric strength in volts per millimeter implies a uniform potential gradient, or, in other words, that the drop in voltage is uniform throughout the thickness of the stressed insulation. This condition will not usually obtain in actual circumstances. In an electric cable, for instance, the rate of fall of voltage, or the potential gradient, is greatest near the conductor. In such a case, therefore, the potential gradient could not be calculated by dividing the total voltage by the thickness of the insulation, as this would give the average gradient, whereas the breakdown pressure would rather be fixed by the maximum gradient. It should further be noted that when alternating pressures are being considered, the maximum value of the pressure should be taken into account when considering the factor of safety of insulators. Since with a sine wave this maximum is $\sqrt{2}$ times the virtual value as indicated on a voltmeter, it appears that the stress on insulators with an alternating current system is greater than with a direct current system of similar voltage.

The foregoing notes have touched briefly upon the nature of the fundamental properties of insulators. It may be repeated that, in the light of present knowledge, these properties are independent, nor are either of them known to have any connection with any other physical properties of such substances. Doubtless the progress of scientific enquiry will in time shed some light on these matters, and any information as to the ultimate nature of the electrical properties of insulating substances would be of the greatest assistance to all branches of the electrical industry.

INDUSTRIAL LIGHTING.

The latest trade publication on this subject to reach us is from the Edison Swan Electric Co., Ltd. It runs to 76 pages, and is designated List No. GG212. After a few pages devoted to information of use to contractors, architects, users, and others, full particulars are given of the various reflectors for industrial lighting supplied by the company. Included are Holophane, Ediswan "Linolite" in its various forms, Ediswan reflectors, especially suited to shop window illumination, Benjamin reflectors, "Maxlume" vitreous enamelled steel reflectors, "Reflecto-metal" reflectors, "Dugdill" patent brackets, lanterns for all purposes, semi-indirect fittings, Wardle reflectors and miscellaneous reflectors and accessories. The "Reflecto-metal" reflectors are made of the same material throughout, the inside "silver lustre" being brilliant and permanent. It does not tarnish, but if it should become slightly dull it is only necessary to rub it lightly with a dry "Selvyt" cloth.

Enough has now been said to indicate the contents of the publication, which, without doubt, will be found of much service in practice by those for whom it has been prepared.

BRITISH INDUSTRIES FAIR.

The official prospectus of the third B.I. Fair, to be held at the Castle Bromwich Aerodrome, Birmingham, from February 27th to March 10th, 1922, has been issued. This section is now thoroughly comprehensive of the Hardware, Metals and Engineering Trades, as in addition the classification under which exhibits have hitherto been invited the B.O.T. has included engineering in general, all Metals, Agricultural Implements and Appliances, Mining, Colliery and Quarrying, Brewing, Distilling and Catering Plant, Construction, Building and Decorating.

It will be remembered that the report of the Warner Committee appointed by the B.O.T. to consider the future of British Industries Fairs, recommended the continuance of the Birmingham Sect., owing to its having received such representative support from the trades included in the schedule to justify it being considered a national fair. It undoubtedly promises to be one of the greatest instruments in the increase of British overseas trade, and it behoves every manufacturer to be represented, both in his own interests and to make the various sections thoroughly representative of British enterprise. The trades represented in this schedule form the most important section of the country's trade, and universal approbation has been accorded in no uncertain terms by visitors from all parts of the world, who have expressed their appreciation of the wonderful display by the manufacturers who have participated.

Manufacturers are urged to further the efforts of the Council by assisting to provide what should be absolutely incontrovertible testimony to the supremacy of British trade by producing such a display as will add an inestimable value to the goodwill possessed by British commerce throughout the civilised world. This cannot but react favourably upon individual exhibitors. Even those who may feel that circumstances are unpropitious for the enlargement of their commitments will agree that propaganda work is likely to prove invaluable for the future when the conditions become normal.

The Birmingham Fair, it is instructive to note, is an organisation incorporated under licence by the B.O.T., and under the terms of its incorporation cannot be a profit-making undertaking. Under the Articles of Assocn., any possible surplus that may be made in any year or accumulated from year to year cannot be distributed, but must be devoted to furthering the maintenance and extension of British commerce, by means of the Fair, or some other similar undertaking.

From data gathered at the past two Fairs the Council has now registered the names of many thousands of buyers, of whom a large proportion are overseas. Official invitations will again be extended to these, and their comfort and convenience studied in every way. The Fair will be extensively advertised in the home and foreign trade Press. In addition the Birmingham Council will again co-operate with the D.O.T. in an extended overseas propaganda campaign.

A carefully compiled catalogue of the Fair, in three languages and in full detail, is published by the Council and distributed free to buyers. The publication is much appreciated as a Buyers' Book of Reference and circulates throughout the world, being issued by the Board of Trade also to all British Diplomatic, Consular and Commercial Officers in H.M. Dominions and in foreign countries.

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The area available for the exhibition is 170,000 sq. ft., and applications for space must be made to the General Manager, B.I. Fair, Chamber of Commerce, Birmingham, as soon as possible and in no case later than Oct. 25. Allotments of space are made strictly in order of application.

THE ENGINEERS' CLUB.

The Engineers' Club having been duly formed (the progress in its formation has been noted from time to time in our columns), its convenient, well-appointed premises were opened on the 1st inst. The membership approaches 3,000 and is being added to at the rate of about 100 per week. Until the end of the month there is no entrance fee, but after that date an entrance fee of 5 guineas will be imposed on new members residing in the United Kingdom. The large number of members testifies that the Club was really wanted, and it will be of the greatest convenience to engineers, especially those abroad and in the provinces on their visits to the Metropolis. The fine premises at 39, Coventry Street, W.1, which form the Club's home, were originally occupied by the Lyric Club, followed by the Walsingham, Motor and then the Road Club. Thus the building may be said to have a social history, and the Engineers' Club were most fortunate in obtaining possession of such luxuriously furnished premises in such an accessible position.

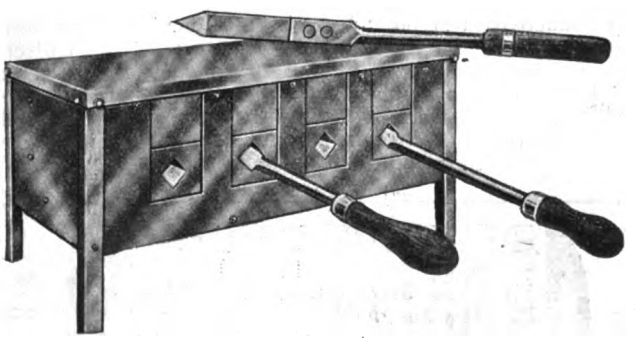
There are 76 quiet and comfortable bedrooms with a fireplace and P.O. telephone in each. The billiard room, with five Burroughs and Watts' full-size tables, is one of the finest in London.

There are also: a large lounge, smoking room, reading room and library, card room, writing room, conference room, and rooms set aside for private lunches and dinners. Of the three dining rooms, each capable of comfortably seating 85 at small tables or 125 at set banquets, one is reserved as a "Strangers' dining room," for the use of members' guests, and is open to ladies after 6 p.m., for theatre dinners and suppers. In addition there is an up-to-date American bar and hairdressers' shop, while the kitchen and service arrangements exemplify the most modern practice.

An interesting feature of the club is that its suites of rooms are all named after famous engineers—Watt, Stephenson, Kelvin, Faraday, Wren, Telford, Dalton, etc.

THE ELECTRICAL HEATING OF SOLDERING IRONS.

On account of the liability to early burn out of the electric soldering irons hitherto put on the market, the Electric Heating Co. (George Street, Croydon), have designed, and applied for a patent covering it, a stove for electrically heating standard soldering irons. To avoid waste of heat owing to its passage to the iron across a considerable air gap the Electric Heating Co.'s stove is so constructed that the heat is transmitted to the iron direct



through a pair of V shaped jaws closed at the rear, one of which is yieldable so as to provide an expansible heating chamber, which can be varied in size to suit irons of different sizes, the arrangement being such that, no matter what size iron is to be heated, the jaws will open and make direct surface contact therewith. The channels in the jaws can be made any shape to suit any shape of iron, so as to ensure the maximum area of the iron being brought into contact with the jaws. The stove is made to take any number of irons at one time, and each pair of jaws is lagged with heat-resisting material. The connections inside the back of the stove are made of corrugated strip nickel so as to permit of easy movement of the jaws without damage to the connections.

One of these stoves is on view at stand No. L210 at the Shipping, Engineering and Machinery Exhibition at Olympia, along with the various "Elect" irons for domestic, laundry and tailoring purposes, together with a range of electric kettles. The stove is shown in the accompanying illustration.

LOW POWER-FACTOR.*

By R. O. Kapp, B.Sc.

The principal disadvantages of a low power-factor from the supply engineer's point of view are:—

1. The capital cost of the electrical part of an undertaking is inversely proportional to the power-factor. If the cost of this part is £15 per KVA of maximum demand, which is a moderate figure, this becomes 18.8 per KW of maximum demand at a power-factor of 0.80. So the bad power-factor necessitates an additional expenditure of £3 8s. per KW. The capital charges on this at 15 per cent. are 137 pence per year. If the load-factor is 25 per cent., a maximum demand of one KW represents about 2,200 units sold per year, and the bad power-factor costs us 0.062 pence per unit. If the tariff was worked out on the assumption that the average power-factor would be 0.8, it would pay the undertaking to offer a rebate of anything up to, roughly, five shillings per 1,000 units to any consumer improving his power-factor to unity.

2. Wherever the station busbars are sub-divided by reactances and power has to be supplied from one busbar section to another, which is the normal working condition, it will be found that with a bad power-factor the regulation is very bad, and the alternators on the more heavily loaded sections supply an undue proportion of wattless current, so that the alternators on this section, if designed for the average power-factor of the system, are fully loaded while the steam turbines are not fully loaded. The result is high steam consumption.

3. Wherever a district has a high voltage supply through step-up and step-down transformers, the fluctuation of the consumer's volts is greatly increased by a bad power-factor. If, for instance, the total impedance in the line is 15 per cent., the difference in volts between full load and no load will hardly be noticed at a power-factor of unity, but it will be 10 per cent. at a power-factor of 0.8. So a consumer having a bad power-factor becomes a nuisance to his neighbours, as well as an expense to the supply undertaking.

4. Unless special methods of power-factor improvement are installed the light load power-factor is considerably worse than that at full load on most installations. In consequence, the alternators are fully loaded and the turbines lightly loaded, and the steam consumption at light load such as during week-ends and during periods of trade depression is unduly high.

A low power-factor has also other minor drawbacks, such as increased distribution losses.

The first of the points mentioned above is more important the larger the undertaking, as the cost of the distribution system increases the more the generation of electricity is centralised. Arguments 2 and 3 apply almost exclusively to large undertakings. It will be seen, there-

* Abstract of Paper discussed at the Engineering Conference, 1921 (Inst. of Civil Engineers).

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fore, that the question of power-factor improvement is one of growing importance. We could sometimes neglect it in the past; we shall not be able to afford to neglect it on the super-power schemes of the future.

To be effective, power-factor improvement must be carried out at the far end of feeders—that is, on the consumer's premises. There is no technical difficulty about this. A number of devices are on the market, and have been in use for many years, for this purpose. Their capital and running costs are generally much less than the cost of a bad power-factor, so that their installation is commercially sound and in everybody's interest, as it must eventually result in cheapening electricity. The difficulties of supervision and divided responsibility make it undesirable for the supply undertaking to pay for devices which are accessories to the consumer's plant, and so the problem for the supply engineer is to devise a tariff which will cause the consumer to instal such devices.

To be effective, such a tariff must make sufficient difference between the electricity bill for a good and a bad power-factor to make it worth the consumer's while to effect the necessary improvement. It must be simple and free from ambiguity: the consumer must be convinced that it is fair. It should be based on integrating or recording instruments rather than on indicating instruments, as the latter type of instrument may be giving anything but a fair average figure at the time when it is read. It must be possible to determine the quantities for which a charge is made with accuracy, and the instruments for doing this must be inexpensive.

A method of charging frequently employed is a slight extension of the usual two-part tariff. In addition to a small charge per unit a fixed charge per KVA of maximum demand is made. This charge places power-factor and load-factor on the same basis, which is not quite justifiable. A bad load-factor affects the capital cost per unit sold of the whole undertaking, a bad power factor only that of the electrical part. On the other hand, a bad power-factor has other drawbacks besides those of increasing the capital charges per unit. The power-factor is under the consumer's control; generally the load-factor is not. A tariff which deals jointly with both is not likely to make it sufficiently obvious to the consumer how he can reduce his bill by installing power-factor improving devices. Another drawback of this method of charging is that no satisfactory maximum demand KVA meter is yet in use. Those used are really maximum current meters, so they depend on the constancy of the supply voltage for their accuracy.

The above disadvantages do not appear to be serious and have not prevented this system from being adopted by some undertakings, but other more direct methods would appear to meet the case better. One such is the well-known Arno tariff. This is a charge per unit consisting of two parts. The first part covers the works costs and as much of establishment charges and capital charges on the non-electrical part of the undertaking as is to be paid for by power consumers. The second part covers the capital charges on the electrical part of the undertaking. In the example given at the beginning of this note the cost of the electrical part was assumed to be £15 per KVA. The capital charges on this are 540 pence a year. At 25 per cent. load-factor and unity power-factor, the sale of units is 2,200 per year. This is 0.25d. per KW hour. Let the first part of the tariff be 1d. per KW hour. The total charge would then be 1d. per KW hour plus 0.25d. per KVA hour.

At unity power-factor the consumer would pay 1.25 per unit; at a power-factor of 0.8 he would pay 1.312d. per unit. That is to say he would pay the 0.062d. pence more than his bad power-factor costs the undertaking. A single meter is used in connection with the Arno tariff which integrates KW hours plus a fraction of KVA hours, so that the bill can be based on a single reading. A modification of this tariff was suggested by Mr. Barbagaleta in a communication to the Italian Association of Electrical Engineers, and later independently by Mr. C. G. Carrothers in the "Electrical Review" of April 1st, 1921, in which two standard watt-hour meters are used, and a simple computation from their readings gives a very close approximation to the Arno charge, which is the scientifically accurate one.

All these methods suffer from one drawback. The consumer is paying for something of which he does not get the benefit: that is, he is paying in one way or another for the idle component of the power. No doubt if supply undertakings start an educational campaign consumers will eventually come to understand that such charges are not only fair, but to the interest of everyone concerned. They will find it much easier to understand this, however, if the adjustment takes the form of a bonus for a good power-factor rather than a penalty for a bad one. It is suggested that tariffs should be based on the assumption that the average power-factor will be 0.8. It is reasonable to expect consumers to have a power-factor of this value without any special appliances, so very heavy penalties may be exacted for values below 0.8. If the consumer improves his power-factor above 0.8 the supply undertaking should allow a bonus of so many pence per 1,000 units for every 1 per cent., by which the average power factor as shown by the readings of two standard integrating watt-hour-meters is improved.

"TERRA-GRIP."

Particulars of the new Simplex "Terra-Grip" continuity system (already referred to in our columns) are contained in a priced list just issued by Simplex Conduits, Ltd. (Garrison Lane, Birmingham). The system, it will be remembered, was introduced to provide a cheaper means of effecting ample and permanent electrical conductivity in light gauge unscrewed conduit installations than is possible with the Simplex Hexagon Grip continuity system.

Each outlet of every fitting (as shown *e.g.* in Fig. 1) has a drilled and tapped boss for housing a steel screw of the formation shown in Fig. 2. After the conduit is inserted into the outlet of the fitting, the screw is driven home,



FIG. 1.



FIG. 2.

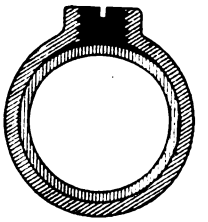


FIG. 3.

and its cup-shaped nose, on making contact with the conduit, expands, as shown in Fig. 3. The enamel is automatically scraped off the conduit, thus ensuring a high degree of continuity. Further, the expansion of the cup-shaped nose automatically locks the screw in position, thus making it impossible to loosen under vibration—an important advantage.

Conductivity test on "Terra-Grip" Junctions have been carried out by the Electrical Engng. Dept. of the University of Birmingham, by measuring the potential drop in millivolts across a number of Conduit "Terra-Grip" Junctions in series. Currents up to 40 amperes were passed and the average resistance per junction was found to be only three ten-thousandths of an ohm.

ARMATURE REPAIRS
MARRYAT & PLACE,
28, HATTON GARDEN,
LONDON, E.C.1.

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PAGES FROM OUR DESIGNER'S NOTEBOOK

WESTON ELECTRICAL INSTRUMENT CO LTD

AUDREY HOUSE · ELY PLACE · LONDON · E.C.1

The WESTON A.C. WATTMETER.

AN INSTRUMENT OF UNIQUE OPERATIVE CHARACTERISTICS.

The design and construction of an A.C. Wattmeter which will indicate accurately and continuously true average power under the widely differing conditions of frequency, power factor and load occurring in practice is a most complex problem, the complete solution of which is a task of no mean order.

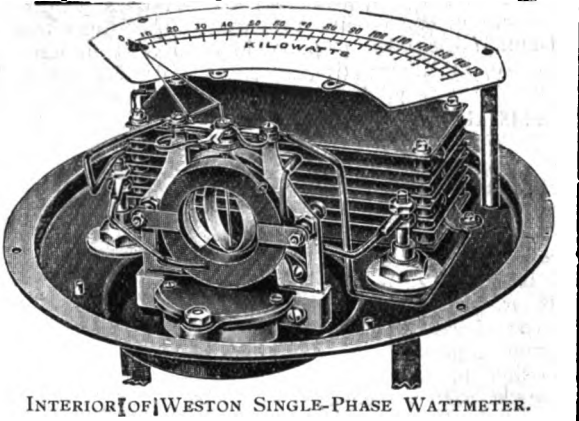
It has, however, been carried into practical effect in the WESTON A.C. Wattmeter, which possesses among others the following important advantages:—

The scale, which is flat and easily read, is uniform throughout the entire range, and, owing to the perfect damping, readings can be made with the same precision on violently fluctuating loads as on steady loads.

The indications of these instruments are equally accurate on D.C. circuits and on A.C. circuits of any commercial frequency, power factor or wave form. They may, therefore, be checked and calibrated with direct current against our Model 1 Instruments, and used on A.C. circuits without the introduction of error.

They have a large overload capacity which will allow the measurement of full power at power factors below 0.50, and the movable system is entirely free of mechanical resonance at frequencies ranging from 15 to 900 cycles.

Accuracy is unimpaired by any changes in temperature, frequency, power factor or wave form within the range of commercial practice. Actual tests over a range of from 15 to 900 cycles showed a total error of only about 1 per cent. even at power factors as low as 0.50, and a rather smaller error was produced by a change in room temperature of 50 deg. F.



INTERIOR OF WESTON SINGLE-PHASE WATTMETER.

The power consumption is negligible. The shunt circuit at 110 volts requires less than 3 watts, and the series circuit consumes only 0.75 watts at full load.

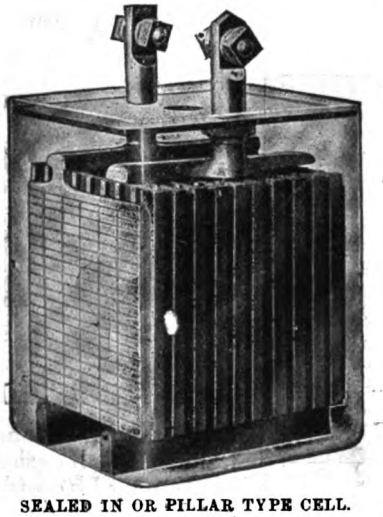
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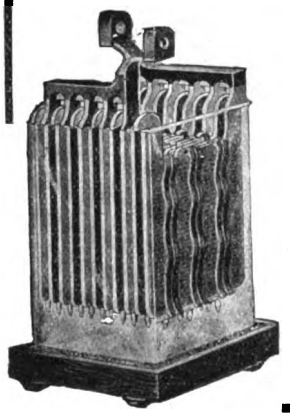
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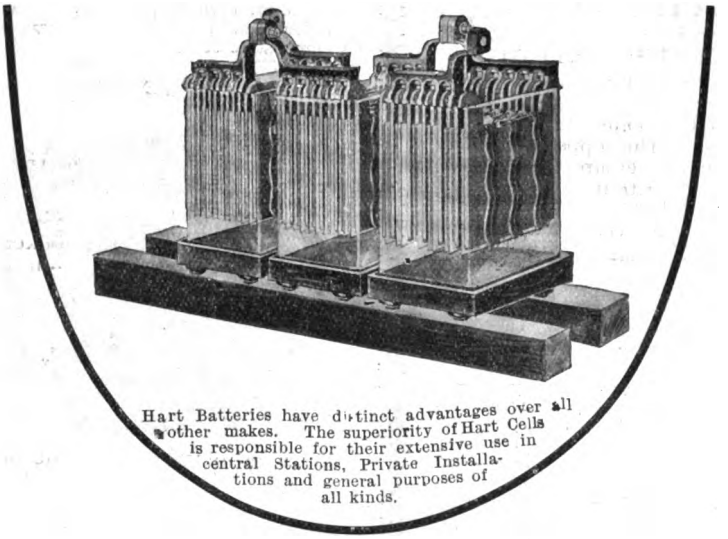
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HART BATTERIES.

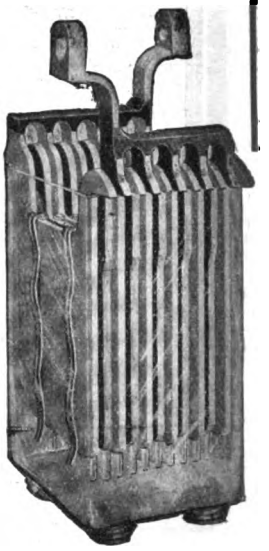
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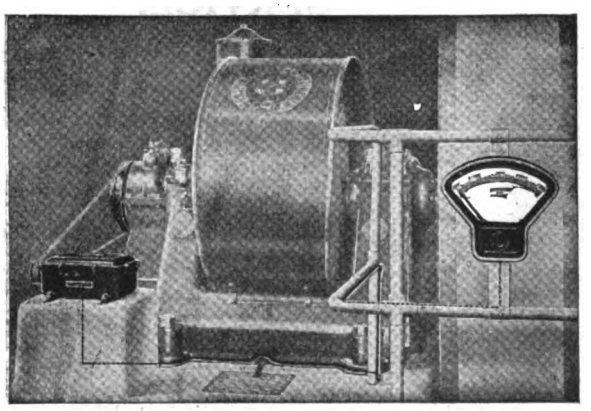
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These machines will be sold only on the understanding that our list price of £15 to consumers is maintained. Orders will be dealt with in rotation. This opportunity should not be missed, as it ensures a very handsome profit indeed. Write at once.

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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 3d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 16-20, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Duplicate Installations.

The sudden failure of illumination in theatres and other public buildings whilst performances, meetings, etc., are in progress, is apt to lead to panic and, in any event causes considerable inconvenience to a large number of people simultaneously. There was a recent instance of this at Leeds, where the electric light in the theatres and music halls slowly died down and eventually went out altogether, causing consternation, especially among the weaker sex. At one music hall the presence of mind of a revue chorus in singing a rousing melody, saved the situation, but there have been numerous instances in the past where the failure of the general lighting system under such circumstances has caused casualties and even loss of life.

It is scarcely surprising, therefore, that the Sheffield City Council, on the recommendation of the Watch Committee, have decided to require a duplicate system of lighting, to be installed in all local places of entertainment. The matter is not difficult to arrange, even where the building does not possess its own alternative lighting plant, or, alternatively, is not in an area served by two supply authorities through independent systems of mains, as is the case in some London boroughs. A storage battery of appropriate capacity, and a simple solenoid or relay change over switch, controlling duplicate lighting units at all important points, meets the case admirably. The subsidiary system need not be of high voltage, so long as the secondary lights are sufficient to illuminate adequately the auditorium or main body of the hall occupied by the public.

The storage battery would require to be kept charged and also made to do a certain amount of work by discharging and recharging at fairly frequent intervals, in order to maintain it in good condition and reliable for such emergencies as may arise. A similar arrangement is described in a German publication. It comprises two lamps, one connected to the mains and the other to a 4-volt. accumulator. So long as current passes through the main lamp, the low-voltage bulb remains dark; on failure of the main current an armature retained by a solenoid in circuit with the mains is released, and switches in the emergency lamp. The lamp switches are so interlocked that the main current cannot energise its lamp unless the safety lamp is in workable condition. Curiously enough, this is by no means the first time such an idea has taken practical shape. At least twenty years ago I witnessed a trial of a similar invention by an Englishman, but, at the time, the provision of duplicate lighting was considered unnecessary as a general rule, and that inventor suffered the usual fate of the man who anticipates the requirements of the next decade.

Fog Penetration.

We are only a few weeks removed from that period of the year when these Isles suffer the usual visitation of mists and fogs, with consequent dislocation of traffic. In a recent issue of my contemporary, *The Gas World*, appears an article on the relative penetrative powers of gas and electric light respectively, when the atmosphere is thus obscured. The question at issue refers to 300 c.p. gas burners as compared with groups of three 100 c.p. Osram lamps. The editorial ruling is as follows, and it is highly amusing to note that advantage is taken of the opportunity to point a moral and adorn a tale, the inference being that this country is subject to fogs all the year round.

"To some extent," says the Editor of *The Gas World*, "this is a matter of personal opinion, and is also affected by the surroundings in each case. No general rule or data can be stated. It is a matter of common knowledge that the larger surface area—four square inches or so, as against a few thin filaments—and the colour, give gas a decided advantage; and that in practice 300 c.p. gas burners have been found more effective for public lighting (*in foggy atmosphere*) than 1,000 c.p. nominal arc lamps. Hence the general use of gas for public lighting, even where electricity is available." *Hence, also, the Pyramids.* The italics are mine, and indicate the natural bias which underlies this editorial comment. It is, of course, a recognised fact that unprotected electric lights with their greater incandescence and white tint, do not compare favourably with the yellower gas flame in those exceptional circumstances when our large cities are fog-bound. The motor driver's antidote is a yellow transparent disc over his headlamps to impart the necessary colour to his electrics, and, after all, the real remedy is to seek an effective fog disperser, which would appear to constitute an electrical problem at bottom.

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From Pub to Power Station.

If all goes well the City of London Electric Lighting Company contemplates the erection of a distributing station on the site of the once famous city tavern, the Castle and Falcon Hotel. If such be the case the click of the beer engines and the foam of the fourpenny will give place to the buzzing of static transformers and the occasional click of switches, or the hum of rotaries; an apt change, marking progress. It is interesting to note that the original home of the Castle and Falcon was the house once tenanted by John Day, the Elizabethan printer, over Alders Gate. On the demolition of the gate in 1761 the tavern was transferred to the site which is the subject of this paragraph.

The Lawyers' Pickings.

As usual, the Law is getting all the honey out of the electrical hive as represented by the Electricity Commissioners' activities. Acts of Parliament are framed for the enrichment of the legal profession, and the Electricity Acts are no exception. They even threaten to bankrupt the industry if we are not careful. Take the case of the big electricity inquiry at Liverpool of recent date; had it not been for counsel's fees and other legal charges the Birkenhead Electricity Committee would have been able to show a profit on its undertaking for the past year. As things turned out the inquiry was a very expensive matter for Birkenhead ratepayers, and counsel's bill of £1,375 odd involves the borough in a debt of £788. Moral, keep clear of the law and lawyers. Why on earth it should be necessary to employ a bevy of legal experts to argue the pros and cons of electricity supply, a purely commercial-technical proposition for any district, passes my understanding, and, I imagine, that of most readers.

The Tables Turned.

A vacuum has been defined by a schoolboy as "a hole with nothing in it"; also, as "what Nature abhors." It aptly described the condition of our coal bunkers and cellars during the recent coal strike, and now it is being pressed into service to handle coal, once more available for industry. The vacuum process of coal handling has been applied to the unloading of coal from barges at the City of London's Electric Supply Company's Bankside depôt. On the wharf is a tower 65 feet high, with platforms at different levels. On the top platform is a receiver from which flexible piping extends down into the hold of the boat to be unloaded. One section of the receiver is connected with a vacuum pump, which exhausts the air from it thus sucking up the coal from the barge to the receiver. Only filtered air reaches the suction pumps. From the receiver the coal drops through a double-compartment air-tight box on to an endless belt, which conveys it to the storage bunker or to trucks. Coal up to four inches in size can be raised, and sixty tons per hour are dealt with by each of the two plants now at work.

ELEKTRON.

Meetings.—The next meeting of the Birmingham and District Electric Club will be held at the Grand Hotel, Colmore Row, on Saturday, 10th inst., at 7 p.m. prompt. Paper: "Canadian Notes," illustrated with lantern slides, by Mr. N. Deykin, vice-president.

EXPERIENCES AS AN "AMATEUR STAGE ELECTRICIAN."

By G. E. MOORE.

There was a time when the "stage" cast a spell over the writer, and although he never gravitated into the theatrical profession, he did blossom forth as an actor in an amateur company. It was the sort of company in which each "star" was so dazzled by his or her luminosity as to be quite oblivious of anybody else! The writer (let it be gently hinted) was not a great success. He was disillusioned one evening when, after an impassioned love-speech which left him breathless and should have awed the audience, the latter burst into raucous laughter!

However, the writer did not altogether sever his connection with the (amateur) stage. Instead, he turned his skill as electrician into account by assisting with stage-lighting and kindred effects, and was so successful as eventually to be in great demand. Hence his title of "amateur stage electrician."

The work really was interesting, because of the many possibilities. Few amateur shows are stage-lighted effectively, and often a show with mediocre acting can be saved by good scenic and lighting preparations. Of course they are very different from "professional" shows; much more improvisation and petty details must often be undertaken—perhaps all the gear has to be taken to the spot. Typical bugbears are finding the wiring, etc., not of big enough carrying capacity, and (worse still) all sorts of faults like bad connections and treacherous fuses suddenly introducing themselves. But there are many gratifying effects which can be experimented with and carried out, and in this connection the writer found the Lundberg switches and switching methods very useful. And what of the thrill which comes when, perched on the top of a rickety ladder with a hot limelight box on one's knee, some forgetful artists blunder into the shaky structure?

As showing the variety of simple yet artistic "effects" which are possible, the writer will describe one production in which he assisted. The play (by Strindberg) was in one act and the action took place in the kitchen of an old mansion. The stage-setting included a fireplace, old beams across the ceiling, a door and a window—through which the distant mountains could be seen. All the lighting was obtained by ordinary filament lamps. By carefully arranging some of these along the front and sides of the stage and also behind the beams, a very even and unobtrusive illumination was given; two or three lamps and some red paper provided the fire; whilst the backcloth on which the mountains were painted was illuminated by lamps slung from a horizontal wire—some lamps being tinted blue and some red. Three liquid rheostats were in circuit.

When the curtain rose, the fire lamps and the blue lamps for the backcloth were "on." As the action proceeded dawn came; this was effected by slowly bringing-up the footlights, etc., and the red lamps lighting the backcloth to full pressure, the latter red lamps afterwards being dimmed out while white lamps gradually replaced them. From then until the end of the play, the backcloth lights (being slung on a wire) were moved along, and by this being slowly carried out, the effect was as though the sun shone more and more directly into the room.

Of course such effects require preliminary work. In this case the "props" were rigged up on the previous evening. As usual there was trouble with the "juice." A fuse blew, and it was located near the meter. To reach it a door had to be battered down, and a long, damp underground passage negotiated; and then, in the dim candlelight, the fittings were seen to be so eaten away by electrolysis and the like as to be falling to pieces! This is the sort of preliminary to be expected.

Another ambitious undertaking concerned a production of "The Trojan Women." When this Greek play opens the god Poseidon and the goddess Pallas Athena appear and disappear; this illusion was effected with the aid of Nernst lamps which normally were used for mirror gal-

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vanometers. A Nernst lamp was placed on each proscenium pillar and directed to that part of the stage where the god or goddess was to appear. The stage being in darkness, No. 1 Nernst was switched on and in the faint light given by the heater the god was seen to appear; this was followed by the filament automatically and brilliantly lighting up. No. 2 Nernst lamp was then switched on and the goddess became visible to the audience in similar manner. Upon switching off, the god and goddess fairly rapidly vanished from sight. Dawn was then effected by bringing footlights, etc., up to full pressure.

The wall of Troy occupied the background, and beyond that a lecture screen was dropped and flooded with blue light. Later, Troy is supposed to be set on fire. This was simulated by an arrangement of orange, red and white lamps placed behind the wall of Troy and operated there by a sort of keyboard arrangement whereby a flicker of vari-coloured light was given. The ordinary illumination was also changed to red.

When the production was shown in public the initial performance took place before a youthful audience. It was to be a sort of final rehearsal for the company. All went well until preparations were made for the fire of Troy. The writer took his place behind the wall. Unfortunately, one or two serious cracks had developed in the latter, and owing to these and one or two incautious appearances over the wall, many members of the audience recognised the wrter. They not only recognised him, but told both him and their pals, and quite a babel of voices could be heard as they speculated on what was going to happen. All this was highly improper, as it spoilt the atmosphere of umpteen years B.C.

The fire of Troy would have been a great (electrical) success had the writer not hearkened unto the voice of a technical tempter, who advised the use of a little smoke. This smoke, it appeared, could quite readily be prepared by mixing the vapours of ammonia and hydrochloric acid. It *could*, but no mention was made as to its venomous nature! The mixture, indeed, was so powerful that the gallery patrons began to cough. One of the "stars," stamping her foot, said it was abominable and left the stage; while the writer, in a state of collapse, was hauled from behind the wall of Troy—nobly operating his fire switches and the smoke apparatus to the very last.

On the following evening the real production took place—the fire of Troy, however, raging without the aid of smoke and without its *electrical basis* being so obvious viâ the cracks in the wall.

There was one occasion upon which the writer had a double role—that of electrician and black magician. As electrican he stage-lighted for the rest of the company, and in the black magic show for himself—the stage being draped with black and the footlights and headlights being turned to face the audience. Before this particular show took place a fuse blew, with the result that each pair of the clusters of lamps in the hall were *put in series!* After a long search the blown fuse was found in the distribution box fifteen feet from the floor and immediately under the ceiling. As usual there was no step ladder big enough or even safe enough, and one had to be borrowed down the road. The writer's work as electrician proved so exhaustive that when he came to essay his job as a venerable black magician, he really wasn't "up to it"; to add to his trials his girl assistant wouldn't scream when her head was chopped off, and he had, perforce, to supply a piercing scream instead.

Whilst in the Royal Engineers, and during that exacting time when "demob." was awaited, he was called in to supply some effects for a dance—the battalion sergeants having netted a number of local V.A.D.s, "Waacs," and so forth. A moonlight effect was arranged by putting all room lights out and illuminating the place from a neighbouring roof by means of a big half-watt lamp. Going a step further, a thunderstorm was thrown in (an innovation which resulted in very mixed feelings on the part of the dancers).

The moon was extinguished, and the writer, standing beside it, gave a few deft flashes with a couple of insulated carbons and twenty amps. Below, a couple of valiant assistants supplied the thunder by means of biscuit tins flattened out. The astonishing thing about this thunderstorm was the phase relationship; sometimes the thunder would "lead" the lightning and sometimes "lag."

The thunder and lightning display came to a sudden and dramatic end when the writer, blinded by the flashes, lost his footing and descended upon the thunder-makers, one of whom broke into particularly violent language when a red-hot carbon touched his neck. The fall from the roof was apparently taken to be the descent of a thunderbolt, and with this "cue" the room lights were turned on again.

On with the dance! Little recked the merrymakers of the scene of anguish outside and of the fate of a spectator of the tragedy, who made an unseemly inquiry as to whether the gentleman rubbing his burnt neck was suffering from heat shock or electric shock.

NEW CADMIUM VAPOUR ARC LAMP.

Intense sources of practically monochromatic radiations are important for many investigations in physical optics and spectroscopy, but unfortunately, the number of such sources at present available is very small. Lamps containing pure cadmium in transparent silica envelopes have indeed been designed and successfully used (Michelson, Fabry and Buisson, etc.). The employment of these lamps, however, is usually attended by serious difficulties, such as: the necessity for keeping the lower portions of the lamp cooled by running water, the adhesion of the metal to the silica walls often resulting in the fracture of the container, the automatic increase in pressure requiring frequent pumping, the relative complexity of construction making repairs troublesome, etc. Accordingly, a brief account of a new cadmium lamp designed and tested by F. Bates, which seems to be free from all of the serious inconveniences pertaining to the earlier forms, may not be without interest.

According to information which has been published in American journals, the fundamental idea was to find a chemical element that would readily alloy with cadmium and possess a relatively low vapour pressure. It was discovered by trial that the rare metal gallium fulfilled the conditions admirably. The author says: "In fact, the addition of a few drops of gallium to ten or fifteen cubic centimetres of cadmium completely changed the texture of the latter, rendering it relatively soft and greatly reducing its tensile strength. Subsequently it was discovered that upon distilling the cadmium from the alloy at a pressure of 0.001 mm of mercury, the minute quantity of gallium carried through was sufficient to completely change the character of the cadmium, and to prevent adhesion between the cadmium and the walls of the lamp."

When finally filled and sealed off from the pump, the shape of the lamp was that of the letter U inverted, the lower ends consisting of vertical capillary tubes. The total internal volume of the silica envelope was about ten cm^3. The electrodes were made of tungsten wires, which projected above the upper ends of the capillaries into the gallium-softened cadmium. The lower ends of these wires and of the capillary tubes were closed with lead seals of the type described by Sand. The precautions taken in filling a lamp of this kind are not stated.

The lamp may be started by heating with a flame to vaporise some of the metal. The lead seals alone must be kept cool by directing a current of air against them. The energy required may be conveniently obtained from the ordinary 110-volt lighting mains. The lamp will operate continuously with a current as small as 3 amperes accompanied by a drop of 14 volts across the terminals. "The most satisfactory results, however, are secured with a current of about 7 amperes and a drop across the terminals of about 25 volts. Under this condition a practically pure cadmium spectrum of great brilliancy is obtained." The fact that the author found it difficult to bring out even a

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few of the gallium lines is just what might have been predicted from the spectroscopic behaviour of this metal and the conditions of excitation prevailing inside the lamp.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 124.

How would you find the direction of phase rotation on 2- and 3-phase systems? Is it possible to determine the direction of rotation of induction motors before switching on the current?—"S. H. ADAMS."

QUESTION NO. 125.

How would you calculate the number of turns in the stator windings of an induction motor? It is presumed that a few of the factors are known, such as:—speed, voltage, frequency, etc.—"S. H. ADAMS."

(Replies to questions Nos. 124 and 125 must be received not later than September 24, 1921.)

Answers to Questions.

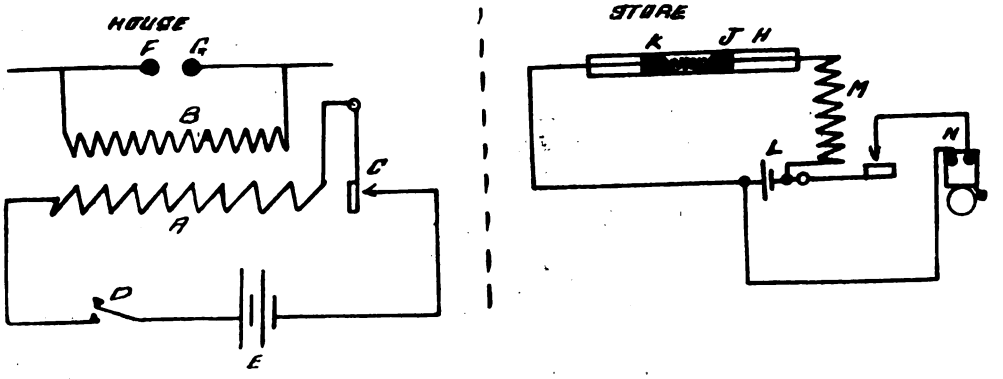
QUESTION NO. 120.

The distance between my house and a store is two miles. I wish to rig up a signalling apparatus between them so that I can be called up at the store if I am required at the house. I do not wish to go to the expense of fitting electric bells on account of the cost of wire and the inconvenience of running them. Can I use a system of wireless? If so, please can you give me some details that will assist me? —"COHERER."

REPLIES TO QUESTION NO. 120.

The first prize (10s.) has been awarded to "B. L. Y." for the following reply:—

A system of wireless signalling to suit the conditions stated is quite feasible, and the details of the system are given below, but it must be left to "Coherer" to ascertain the approximate cost, and decide whether it is preferable to install this or a bell arrangement. The sketch herewith will help to explain the working, which also shows the method of connections, the lettering corresponding with those given in description. At the house-end will be installed an induction coil transmitter, which consists essentially of an induction coil fitted with an interrupting device (*C*), and a contact key (*D*) for signalling. The source of power would be a set of primary or storage batteries (*E*) of about six volts, the capacity depending upon the size of induction coil used. The primary winding (*A*) of coil is connected to battery through interrupter and contact key, whilst the secondary (*B*) is connected to two brass balls or spheres (*F*, *G*), between which there is a small air gap. This spark-gap or oscillator is in circuit with the aerial (not shown on sketch), one end being connected to the air-wire and the other to earth.



At the store-end a form of receiver is necessary, and a suitable form would consist of a coherer, which comprises a glass tube ((*H*) fitted with two metal plugs (*J*, *K*), and containing in the space between these a mixture either of nickel and silver filings, carbon and cobalt, or of carbon only. If the latter be used, the device will be self-decohering, that is, no mechanical arrangement will be required to restore the filings to their original positon after transmitter ceases to work. Otherwise, a tapping device would be required, as the principle upon which this coherer works is that normally the resistance of the filings is several thousand ohms, therefore sufficient current cannot flow from the single cell (*L*) to energise the relay (*M*). When, however, the waves are emitted from spark-gaps (*F*, *G*), and reach the coherer, the resistance of the filings is reduced sufficiently to allow current to flow from battery (*L*), and energise relay, which may be used to close a local bell circuit, which bell (*N*) forms the calling up device. It will be, therefore, seen that current will still flow through coherer, after the waves from transmitter cease, unless the filings are mechanically jarred to restore them to their normal high resistance, unless composed of carbon, as stated above. Carbon filings are not so reliable as the other mixtures, but might be sufficiently so for the purpose required; if not, a trembler bell would make a suitable tapping device, the hammer engaging with tube of coherer, so as to tap same lightly so long as the relay holds the local circuit closed. This bell might be utilised so as to also act as the signalling device in place of bell (*N*).—"B. L. Y."

No second award is made.

REPLIES TO QUESTION NO. 121.

No satisfactory replies were received in connection with this question. No prize has, therefore, been awarded.—Editor, ELECTRICITY.

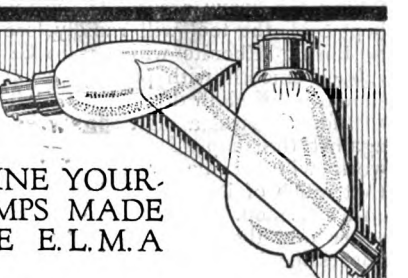
EBONITE.

Ebonite, also called vulcanite and hard-rubber, being very stable towards chemical reagents, air, light and changes of temperature up to about 175 deg. F., is a very suitable insulating material in many electrical appliances, as is well known. It is manufactured in large quantities at the Woolwich works of Siemens Bros. and Co. Ltd., and a catalogue (No. 190) has just been prepared. In this are to be found illustrations of the workshops and particulars of the six standard qualities manufactured, quotations for which, in the form of rod, tube, sheets, or mouldings, will be promptly supplied on receipt of requirements. The better qualities are black, the others red or mottled.

In machining ebonite care should be taken that the tool is sharp and that there is no tendency to overheat by

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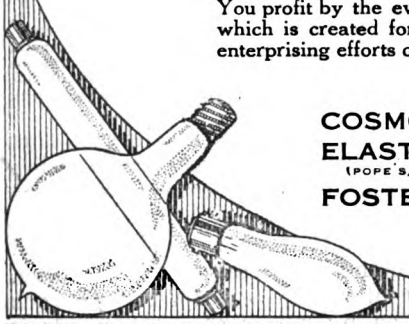
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19

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taking too heavy a cut. If the tool and the work are not kept cool, the tool will rapidly lose its edge and the work be burnt. Ebonite which is to be polished should first be rubbed smooth with pumice powder. The polishing mops should be of cloth dressed with "Tripoly" compound, and should be run at a high speed, the work being held lightly against the mop. If too great a pressure is exerted the work will become overheated and the mop distorted, so that much of its effect is lost. A final gloss may be given on a dry mop. Further, ebonite can be softened in boiling water and then bent or shaped as desired; the shape or impression is fixed on cooling. It should be noted, however, that if the ebonite is subsequntly softened by heat it will return to its original form.

The company point out that in the manufacture of ebonite sheet metal foils are used as a backing for the plastic material during the process of vulcanisation, and they give to the finished sheets that glazed surface which is well known. This surface is always slightly metallic, and although every precaution is taken to minimise this condition, it is essential where ebonite sheet is used for electrical work that this metallic surface be removed, as otherwise it will result in low insulation due to surface leakage. This metallic surface can be removed and the sheet supplied with a smooth matt surface, and it is strongly recommended that all sheets intended for electrical work be so treated. When this is required, a remark to the effect that the sheet shall be "free from metallic surface" should be made on the order. If untreated foil surface sheets are used, the precaution must be taken of instituting a severe insulation test on each sheet before it is passed on to the shops for cutting and assembling. (It will be remembered that recently ELEKTRON referred in "Current Topics" to the dangers in electrical installations due to neglect of this precaution.) Reference is also made in the catalogue to Keramot—a high-class insulating material which has been introduced with the object of superseding the German-made Stabalit. Messrs. Siemens claim that its insulation resistance, dielectric strength, critical softening temperature, tensile strength, non-hygroscopic qualities and its behaviour in oils and acids are all equal or superior to Stabalit. After twenty-eight days' immersion in water its increase in weight is only 0.1 per cent. The specific gravity is about 1.65, and its tensile strength about 4,000 lbs. per square inch at normal temperatures.

It is particularly suitable for insulating metal parts of rubbing contacts, where it is essential for the insulation and the metal to wear uniformly, as, for instance, in certain parts of ignition magnetos. For such purposes Keramot shows further advantageous qualities inasmuch as it possesses a lower coefficient of expansion than other materials hitherto employed. Moreover, it does not carbonise readily, and therefore does not become conducting when a high-pressure arc passes across its surface. The material is suitable for all kinds of moulded work, with and without metal parts, and it can be easily turned, drilled and tooled in the ordinary way. It is of a reddish-brown colour and takes a good polish.

DEVELOPMENTS IN ITALY.

According to mail and other advices from Italy, the Italians are making most strenuous efforts to make good the devastation due to war conditions. In spite of internal troubles and the great lack of coal, which was a very heavy handicap, Italy is now on the high road to prosperity. This season over 5,000,000 tons of wheat have been garnered, the oat and barley harvest is a heavy one, and all round the crops are most excellent. In the devastated areas the local populations have undertaken the task of rebuilding their shattered homesteads, and already some 50,000 houses have been restored. Between Venice and Trieste six hundred co-operative societies, representing all sorts and conditions of political parties, have set to work, and the Venetian provinces are rapidly assuming their pre-war aspect. The draining of the great malarial marshes to the north-east of Venice is in full swing again. During the war, 75,000 acres of this territory were flooded, and most of the Diesel plant, which was being used for the purposes of drainage was destroyed. Now the Diesel engines have been replaced by electric plant, and land is being reclaimed at express speed. Again, the Italians are making excellent progress with the harnessing of water-power. According to the Rome correspondent of the *Times*, skilful use of the Lake of Santa Croce will soon result in the generation of 250,000 h.p., which will enable the Piave to supply electric light from Pola to Ancona at a saving of some 1,000,000 tons of coal per annum. The Tagliamento also is being harnessed, and the experts are of opinion that within a short time it will be producing 50,000 h.p. for the use of Italy's industries.

ELEMENTARY DETERMINANTS
WITH SPECIAL REFERENCE TO KIRCHHOFF'S LAWS.

By H. P. FEW,
Silver Medallist in Telegraphy, etc.

TWELFTH ARTICLE.

NOTE.—The aim of these articles is to bring out prominently the advantages of employing determinants, in conjunction with Kirchhoff's laws, for finding current values in networks of conductors. The previous articles appeared in our issues of June 25, August 6 and 27, September 17, October 22, December 3, 1920, February 25, March 25, May 6, June 24 and July 29, 1921, and gave an account, *inter alia*, of Kirchhoff's laws and corollaries, Maxwell's cyclic equations, general methods of evaluating determinants, application of determinants to finding current values in simple networks, including the Wheatstone Bridge, Thomson double bridge, bridge duplex and leak systems of telegraphy, etc. This article deals with an important problem in wireless telegraphy.

In this article we employ the methods of determinants in investigating the properties of three magnetically-coupled circuits—a problem of considerable importance in wireless telegraphy.

In the *Electrician* of July 16, 1920, E. Bellini attacked this problem by the method of repeated differentiation, but in the *Electrician* of August 6, 1920, L. C. Pocock suggested that solution by means of determinants is more illuminating in that it brings into prominence several important properties of the system.

Fig 27 shows the three coupled circuits where c_1, c_2, and c_3, are the capacities of the three condensers, l_1, l_2, and l_3 are the inductances, m_{12} is the mutual inductance between the first and second circuit, and m_{23} that between the second and third circuit. It is assumed that the resistances of the system is nil and that the frequencies of the three circuits are the same.

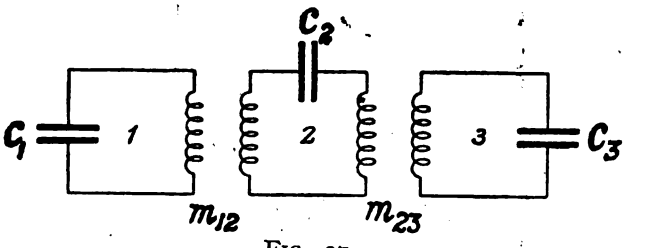


FIG. 27

The differential equations of the three circuits are—

$$l_1 \frac{d^2i_1}{dt^2} + m_{12}\frac{d^2i_2}{dt^2} + \frac{i_1}{c_1} = o$$

$$l_2 \frac{d^2i_1}{dt^2} + m_{12}\frac{d^2i_1}{dt^2} + m_{23}\frac{d^2i_3}{dt_2} + \frac{i_2}{c_2} = o$$

$$l_3 \frac{d^2i_3}{dt^2} + m_{23}\frac{d^2i_2}{dt^2} + \frac{i_3}{c_3} = o$$

where i_1, i_2 and i_3 represent the currents in circuits 1, 2 and 3 respectively.

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If p be the frequency then we may put $d/dt = ip$ and $d^2/dt^2 = -p^2$, where $i = \sqrt{-1}$. The three equations then become—

$$\left(l_1p^2 - \frac{1}{c_1}\right) i_1 + m_{12}p^2 i_2 = o$$

$$m_{12}p^2 i_1 + \left(l_2p^2 - \frac{1}{c_2}\right) i_2 + m_{23}p^2 i_3 = o$$

$$m_{23}p^2 i_2 + \left(l_3p^2 - \frac{1}{c_3}\right) i_3 = o$$

The following determinant may be formed from these three equations by eliminating i_1, i_2 and i_3, the roots of which give the values of p satisfying the circuit conditions—

$$\begin{vmatrix} l_1p^2 - \frac{1}{c_1} & m_{12}p^2 & o \\ m_{12}p^2 & l_2p^2 - \frac{1}{c_2} & m_{23}p^2 \\ o & m_{23}p^2 & l_3p^2 - \frac{1}{c_3} \end{vmatrix} = o$$

Expanding this determinant we get—

$$\left(l_1p^2 - \frac{1}{c_1}\right)\left(l_2p^2 - \frac{1}{c_2}\right)\left(l_3p^2 - \frac{1}{c_3}\right) - m_{23}^2p^4\left(l_1p^2 - \frac{1}{c_1}\right) - m_{12}^2p^4\left(l_3p^2 - \frac{1}{c_3}\right) = o$$

and dividing throughout by $l_1l_2l_3$—

$$\left(p^2 - \frac{1}{l_1c_1}\right)\left(p^2 - \frac{1}{l_2c_2}\right)\left(p^2 - \frac{1}{l_3c_3}\right) - \frac{m_{23}^2}{l_2l_3}p^4\left(p^2 - \frac{1}{l_1c_1}\right) - \frac{m_{12}^2}{l_1l_2}p^4\left(p^2 - \frac{1}{l_3c_3}\right) = o$$

Putting $\frac{m_{23}^2}{l_2l_3} = k_{23}^2$ and $\frac{m_{12}^2}{l_1l_2} = k_{12}^2$, we have

$$\left(p^2 - \frac{1}{l_1c_1}\right)\left(p^2 - \frac{1}{l_2c_2}\right)\left(p^2 - \frac{1}{l_3c_3}\right) - \left(p^2 - \frac{1}{l_1c_1}\right)k_{23}^2p^4 - \left(p^2 - \frac{1}{l_3c_3}\right)k_{12}^2p^4 = o \quad \ldots\ldots\ldots\ldots (1)$$

If the three circuits are tuned to the same frequency we have $l_1c_1 = l_2c_2 = l_3c_3$, and the last equation becomes—

$$\left\{\left(p^2 - \frac{1}{l_1c_1}\right)^2 - k_{23}^2p^4 - k_{12}^2p^4\right\}\left(p^2 - \frac{1}{l_1c_1}\right) = o \quad \ldots\ldots\ldots\ldots (2)$$

from which it is seen that—

$$p^2 = \frac{1}{l_1c_1}$$

is a root. This solution is not a resonance of the middle circuit, however, and the tuning of the middle circuit is not essential to the existence of this resonance in circuits 1 and 3 for equation (1) is zero if

$$p^2 = \frac{1}{l_1c_1} = \frac{1}{l_3c_3}$$

even if $p^2 - \frac{1}{l_2c_2}$ is not zero.

In other words, that the frequencies of the first and third circuits (say p_1 and p_3) are independent of that of the middle circuit follows from the fact that p_1 and p_3 are roots of the general equation whatever be the value of the middle term (22), but it must not be assumed that this is a proof that the current in the middle circuit is not a maximum when $l_1c_1 = l_2c_2 = l_3c_3$. That the middle circuit is not necessarily resonant with the end circuits is deduced from the theory of vibrations, for any alteration in the constants of the middle circuit must alter the natural frequency of every mode involving current in the middle circuit. If, therefore, any given frequency of the end circuits is not affected by the constants of the middle circuit, it follows that $i_2 = o$ (even if $l_1c_1 = l_2c_2 = l_3c_3$). This case has its analogy in a straight bar vibrating in halves with a rode at the middle.

The remaining free periods may be found by solving the remaining factor of (2), viz.—

$$\left(p^2 - \frac{1}{l_1c_1}\right)^2 - p^4\left(k_{12}^2 + k_{23}^2\right) = o$$

which gives—

$$p = \frac{1}{\sqrt{\left\{l_1c_1\left(1 + \sqrt{k_{12}^2 + k_{23}^2}\right)\right\}}} \quad \text{and} \quad \frac{1}{\sqrt{\left\{(l_1c\left(1 - \sqrt{k_{12}^2 + k_{23}^2}\right)\right\}}}$$

These values of p are general solutions of (2) and are common to all three circuits.

If the intermediate circuit contains no condenser the determinant becomes—

$$\begin{vmatrix} l_1p^2 - \frac{1}{c_1} & m_{12}p^2 & o \\ m_{12}p^2 & l_2p^2 & m_{23}p^2 \\ o & m_{23}p^2 & l_3p^2 - \frac{1}{c_3} \end{vmatrix} = o$$

which, on expanding gives—

$$\left(p^2 - \frac{1}{l_1c_1}\right)\left(p^2 - \frac{1}{l_3c_3}\right)p^2 - \left(p^2 - \frac{1}{l_1c_1}\right)k_{23}^2p^4 - \left(p^2 - \frac{1}{l_3c_3}\right)k_{12}^2p^4 = o$$

and since $l_1c_1 = l_3c_3$, we have—

$$\left(p^2 - \frac{1}{l_1c_1}\right)\left\{p^2 - \frac{1}{l_1c_1} - p^2k_{23}^2 - p^2k_{12}^2\right\} = o$$

from which

$$p = \frac{1}{\sqrt{l_1c_1}}, \text{ and } p = \frac{1}{\sqrt{l_1c\ (1 - k_{12}^2 - k_{23}^2)}} \quad \ldots\ldots\ldots\ldots (3)$$

These results can be arrived at directly by putting equation (1) $l_1c_1 = l_3c_3$, retaining l_2c_2, solving and making $c_2 = \infty$, when the same results are reached. The second value of p involves the constants of all three circuits and represents therefore a resonance of all three circuits. Another value of p is zero, which corresponds to the infinite time constant of the middle circuit, so that a practical case would require the consideration of the resistances of the circuits.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.

TRAMWAY MOTORMAN'S HANDBOOK. By W. S. Ibbetson, B.Sc., A.M.I.E.E. (Spon. 6s. 6d. net.)—To the man in the street, the driving of an electric tramcar appears a perfectly simple operation, inasmuch as the car has not to be steered, and there are only two controls to manipulate, viz., the speed lever and brake. In actual practice, however, considerable experience is required to make a good driver, and although the latter need not possess deep technical knowledge, it is highly desirable that he understand thoroughly the fundamental principles of his car, and is taught the right things to do when emergencies occur. A good driver uses a minimum of energy, and is an asset to the company or municipality which employs him.

The present handbook is a praiseworthy and successful effort to provide all motormen with a practical treatise on the subject of their work. It is well illustrated, and eschews technicalities except in so far as they are essential to a proper understanding of the context. The introduc-

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tory chapter gives all the elementary electrical information necessary to enable the reader to comprehend what follows, and the succeeding six chapters deal respectively with Voltages of Supply and Methods of Distribution, Rolling-Stock and Car Equipment, Motors, Brakes and their Operation, Controller and Driving, and last, but not least, Faults—Electrical and Mechanical. The latter are very effectively tabulated under four headings—Indication, Cause, Repair, and Notes, which make for ready reference, and at once give the key to any trouble which may arise in the course of a motorman's duty.

The matter throughout the book is divided into numbered paragraphs, and a very facile index is furnished giving paragraph references.

Summarising, we can cordially recommend this book to all our readers who are car drivers, present or prospective. It will well repay a careful study, and can with advantage be carried on the car even by an old hand.

THE MOTOR CYCLIST'S A.B.C. By Horace Wyatt. (Newnes. 2s. net.)—Speaking generally, the motor-cyclist is extremely well catered for in the matter of handbooks and treatises dealing specially with his hobby.

Having regard to the large number of riders, the progressiveness of the pastime, and the considerable influx of new owners and novices each year, however, there is always room for up-to-date additions to his library, and the book under review is quite good value for the modest price at which it is published.

The first three chapters deal with essential preliminary information, and are primarily intended for beginners. Chapter II., on choice and purchase of a machine and subsequent experiments in controlling and driving the new mount, is particularly serviceable to the beginner, whilst Chapter III., on modernising and overhauling an old machine, will appeal to those of limited means who have to make the best of a second-hand mount.

The A.B.C. from which the book takes its title is really an illustrated encyclopædia of all the usual terms met with in motor-cycling parlance. It is a most complete exposition, although some of the advice given stamps the writer as lacking in all-round experience. For example, apropos of fitting a new link to a driving chain, the reader is instructed to file away the end of the roller pin or rivet, a feat impossible with most leading makes on account of the fact that the ends in question are case-hardened, and no file will touch them. Another hint of doubtful value in connection with stretched chains is to reverse it on the sprockets. This procedure is of little or no avail where a roller chain is stretched out of pitch, because the stretch is equal throughout the links, and reversing it makes no difference. It would be a rider of lifelong experience, however, who could deal infallibly with all the ills motor-cycles are or have been heir to, and, such as it is, this handbook represents excellent advice in the main. We have no hesitation in recommending it to the notice of interested readers and riders.

ELECTRIC LIGHTING FOR CYCLES AND MOTOR CYCLES. By Harold H. U. Cross. (Spon. 3s. 6d. net.)—With the advent of the economical metal filament lamp for low voltages, electric lighting, once beyond the realm of practical politics for the cyclist, has now become as popular, if not more so, than oil and acetylene, and far more convenient. The little book under review is essentially practical, and caters for the amateur, who, with its aid, should be able to master the minor problems associated with this application of electric lighting, and derive much satisfaction from the improved method.

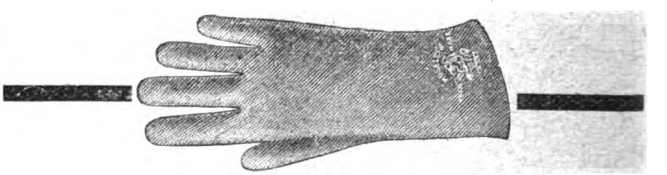
As is usual in such elementary handbooks, Chapter I. deals with essential electrical facts, and in as simple language as possible. A general section on dry batteries and accumulators follows, together with an explanation of how the small cycle dynamo, driven from the machine itself, generates the necessary electrical energy. Chapter IV. describes some convenient dry battery lighting sets for cycle, motor-cycle and sidecar, whilst Chapter VI. deals similarly with accumulator sets, and tells how to make up a 5-ampere hour cycle accumulator, an experiment dear to the heart of most embryo electricians. It is unfortunate that so brief a reference is made in this chapter to the alkaline type of battery, the only one, in our opinion, based on actual experience extending over some eight or ten years, which will stand the vibration and neglect to which these small batteries are subjected. Some useful hints on charging, including the use of rectifiers for A.C., and focusing the lamps, complete a very useful section. The remainder of the book is devoted to descriptions of cycle and motor-cycle dynamos, both A.C. for lighting direct and D.C. for use in conjunction with accumulators. The leading types are illustrated and their various features explained, whilst the concluding pages are devoted to that important subject, adjustments and repairs. We strongly recommend this handbook to the cyclist and motor-cyclist as conducive to freedom from lighting troubles.

Various Items.

Power House Equipment for Canada.—The D.O.T. is informed that a power house is to be erected for the Normal School and Institute of Technology, Calgary, Canada, and it is proposed to instal a steam-driven generating plant. The boilers have been already purchased, but specifications for the remainder of the plant are not yet prepared. British firms interested should send literature, etc., to the Provincial Architect, Department of Public Works, Alberta.

Australia.—H.M. Trade Commissioner in Australia (Mr. S. W. B. McGregor) has forwarded a copy of the report on the Kiewa Hydro-Electric scheme by the Electricity Commissioners of Victoria, which includes the report and estimates of the scheme by Mr. A. G. M. Mitchell, M.C.E., their consulting hydraulic engineer. The reports may be consulted by U.K. firms interested on application at the Enquiry Room of the D.O.T., 35, Old Queen Street, Westminster, S.W.1.

A Storage Battery Contract.—We are informed that the Edinburgh Corpn. have placed an order with Messrs. Pritchett and Gold and E.P.S. Company, Ltd., for two batteries, each consisting of 120 cells, having a capacity of 2,640 ampere hours at the 10-hour rate of discharge. These batteries will be installed at the new power station which the Corpn. are putting down at Westbank, Portobello, and will be able to supply 500 kw. for three quarters of an hour in an emergency. It is interesting to remember that in 1900 Messrs, Pritchetts and Gold supplied a battery to the Macdonald Road Station of the Edinburgh Corpn., and this battery is still giving useful service.



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ELECTRICITY
PRACTICAL TRADE JOURNAL
SEPTEMBER 16, 1921.

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THE ENGINEERING EXHIBITION.

The Shipping, Engineering and Machinery Exhibition at Olympia was duly opened on Wednesday last week, and will be open daily until the 28th inst., from 11 a.m. to 9 p.m.

Although there are few large working exhibits, and none emitting weird, nerve-racking noises, the large area available is filled with a thoroughly representative collection of appliances and equipment pertaining especially to the shipping and engineering industries. The bands of the Royal Marines (Chatham) and Scots Guards render excellent selections during the afternoon and evening, while instructive cinema pictures of engineering interest are shown in the hall in the Northern Gallery. A feature this year is that the keynote of the whole display is British enterprise—it will be remembered that at the 1919 exhibition a large section was given up to Dutch shipping, with the result that over 50 British firms who wished to exhibit were unable to do so on account of lack of space. Altogether, the display is a noteworthy one, and the organisers, F. W. Bridges and Sons, Ltd. (36-8, Whitefriars Street, E.C.4), are to be complimented on the result of their labours. Further, it is gratifying to hear from several exhibitors that already good orders have been booked, mostly for export. Seeing that electricity enters so largely nowadays into engineering work of all kinds, it is difficult to present in the space at our disposal an adequate record of the items of electrical interest, let alone a record of the displays of all the exhibitors, who number over 300.

In previous issues we referred to the exhibits of the B.T.-H. Co., Ltd., Siemens Bros. and Co., Ltd., London Electric Firm and the Electric Heating Co. In connection with our earlier account of the latter's display, we are now able to supplement the description of the soldering iron heating stove with comparative costs of heating an iron by electricity and by gas in the district of Croydon:—Electricity: Load 400 watts, rate 2d. per unit, cost per hour 0.8d. Gas: Rate 5s. per 1,000 cub. ft., consumption per hour 20 cub. ft., cost per hour 1.2d. We understand that the cost for gas was obtained from the Croydon Gas Co., and confirmed by a user of a gas stove for the purpose of heating soldering-irons, also in Croydon.

Metropolitan-Vickers Electrical Co., Ltd. (Stand 90, Row E), show a 120 k.v.a. 3-ph. ship's geared lighting turbo-alternator set, a 30 h.p. motor direct coupled to a winch, an M.-V. "single operator" type welding generator, and a selection of "Cosmos" domestic appliances, including fires, irons, kettles, hot-plate, etc., lamps, lamp-holders, bell-pushes, etc. The winch is controlled by M.-V. push button automatic contactor gear, which ensures correct starting and stopping. The derrick is provided with a limit switch to prevent over-winding. The welding generator is designed for metallic electrode welding to a maximum capacity of 175 amps. This set is arranged in the form of a motor generator set, and the motor starting gear and the generator control panel are mounted on iron brackets attached to the bedplate. Thus the set is entirely self-contained, and complete as a single unit. This arrangement is designated the "semi-portable" type equipment, and is suitable for easy transportation between different parts of a works or shipyard.

Evershed and Vignoles, Ltd. (Stand 299, Gallery), have a most interesting display, including the latest form of Evershed's helm or rudder indicator. The device was originally introduced in 1893, and is used extensively in British and foreign navies and the Mercantile Marine.

It serves to indicate at any desired control position the degree of helm or angle of inclination of the rudder to the axis of the ship. Designed to run off any D.C. supply, it cannot get out of step, and is independent of voltage variation of the supply which operates it. An adaptation of the above is Evershed's steering telegraph. By means of a hand operated transmitter at the control position the degrees of helm required can be signalled to any desired position, such as the engine room or steering flat. Signal gongs are provided with this apparatus which ring automatically when the transmitter is operated.

An entirely novel method of measuring and/or controlling at a distance the speed of an engine or other apparatus is provided by Needham's Pulsator system of speed control and measurement. It also indicates the direction of rotation at a distance with extreme sensitiveness. Needham's revolution counter enables the revolutions of an engine or other apparatus to be indicated and added up at any distance. It will operate up to 400 r.p.m., and indicate single revolutions. For speeds above this it will indicate every 10 revolutions.

Kilroy's Stoking Indicators, introduced in 1902, serve to indicate automatically from the engine room to the boiler room the rate at which it is required to stoke the furnaces. A working model of Kilroy's Turret danger signal system, used for the purpose of giving an automatic warning at one gun position if it is in danger of firing into an adjacent gun, is also shown. This system has been used in the British Navy since 1907. It runs through a motor alternator off a D.C. supply, and is independent of voltage variations. A Direction-of-Object indicator or look-out telegraph, for enabling a man in the crow's nest or forecastle to indicate at the bridge or other control position the bearing of an object at sea, is also shown in operation, whilst space is found also for a display of the Dionic water tester, meggers, bridge-meggers, ducters, ohmmeters, indicating and recording instruments, etc.

E. Brook, Ltd. (Stand 164, Row J), show A.C. motors of the protected, enclosed, pipe ventilated, drip-proof and explosion-proof types. The motors are both squirrel cage and slip ring, and range in size from ¼ to 100 h.p., the wound stator of a 100 h.p. 3-ph. motor being shown. Examples of motors fitted with reduction gears, motors attached to blowers, motors for buffing and grinding, and for working in a vertical position, are also among the examples shown of the excellent products of the Empress Works.

The Jackson Electric Stove Co., Ltd. (Stand 167, Row J), as an example of their products for ship work, show complete electrical cooking equipment for the galley of a small boat accommodating about 50 persons. It is interesting to note that this company equipped over 400 of H.M. submarines during the war, and also supplied a large number of other appliances for cooking and heating food in many capital ships and auxiliaries. Some equipments have been in use over eight years. In addition, a range of cabin heaters and electric fires, as well as small domestic appliances, are shown.

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The Carron Co. (Stand 140, Row G) have among their varied exhibits some of the electric fires, ranges and hot-plates, etc. The fires all have an attractive appearance, while the elements are variously constructed.

Agricultural and General Engineers, Ltd. (Blackstone and Co., Ltd., J. and Fredk. Howard, Ltd., A.G.E. Electric Motors, Ltd., Peter Brotherhood, Ltd., and Clarke's Crank and Forge Co., Ltd.), show on Stand 113, Row F, a representative collection of their well-known manufactures, including dynamos and motors, "Bull" lighting sets, turbo-alternators, steam and Diesel engines, etc.

Vickers-Petters, Ltd. (Stand 172, Row J), also have a most instructive engine exhibit, which embraces semi-Diesel engines and details, including the patented electric torch, Petter-Junior lighting sets, etc.

A thoroughly comprehensive exhibit of switchgear and controllers is made by Laurence Scott and Co., Ltd. (Stand 117, Row F), who also make dynamos and motors in which, even in the smallest sizes, wooden wedges are used in the armature slots so as to avoid the use of binding wire on the cores. In the deck winch control gear shown the relays are timed so that they switch on at a pre-determined rate, whatever the operator does with the master controller. The foot brake is electrically interlocked, so that if used on any but the first step, it cuts off current as long as it is depressed, but when it is released it re-starts the motor. The Scott-Bentley patent load discriminator fitted in this controller is a device for getting over the objection sometimes raised against electric winches, that they are slow compared with steam winches at the light and moderate loads on which they must frequently work. The discriminator allows the winch to be speeded up automatically on the last step of the master controller, provided so doing would not cause an overload on the motor. If the load would be too much it keeps the speed down to that of the previous step of the control until the load is eased. The practical result is considerable speeding up of the average rate of working, without risk of bringing out the overload circuit breaker.

An electrical steering gear system which has been in practical operation on a number of ships since 1914 is also demonstrated. There is a sliding rheostat connected to the wheel and another (in the steering flat) connected to a small telemotor. The latter is excited on the Wheatstone-Bridge principle when the wheel rheostat is moved, and tends to bring its own rheostat back into coincidence. In doing so it drives on a hunting gear connected to which is a master controller. The motor starts, drives back the other side of the hunting gear, and switches itself off. The rudder has then come to rest in the position indicated by the steering wheel.

A number of ingenious devices are to be found on Stand 290, Gallery, where Electrical Utilities, Ltd., show in continuous operation the "Utility" current limiter, the "Lightning" electric oven, a device with radical departures from the conventional gas-stove design, the "Sentinel" excess current indicator, and the "Dim-Bright" adaptor fitting. There are two lamp-holders, in one of which is a Philips' ¼ c.p. night lamp (as described in our columns a short time ago), and in the other a standard metal filament lamp. Which of these lamps is in operation is controlled by a cord-operated switch in the adaptor. The device is simple and of marked utility, e.g., its use in halls, hotels, cinemas, nurseries, hospitals, etc., is at once apparent. Particulars of the other devices mentioned will be given later, as well as descriptions of other exhibitors' manufactures, but we should here mention that the Igranic Electric Co., Ltd. (switch and control gear), and the Rawlplug Co., Ltd., have exhibits that on our first visit were among those which arrested our attention. We would also remind readers that S. Rentell and Co., Ltd., publishers of ELECTRICITY, have hundreds of technical books well displayed on Stand 189, Row K. The leading London evening newspapers are also on sale.

(To be continued.)

SOME ELLISON SWITCHGEAR SPECIALITIES.

We recently had the pleasure of inspecting the newly-extended switchgear works of George Ellison at Wellhead Lane, Birmingham. The shops, with their electric drive, are a model of modern design, are fitted with the latest machinery, and are arranged for the rapid and efficient production of the various items of switchgear for which the firm is known throughout the world. The buildings have saw-tooth roofs, giving an excellent north light.

The main lines of manufacture are air-break and oil-break starting and controlling panels for slip-ring and squirrel-cage induction motors, circuit breakers, "unit" type gear, crane control switch panels, drum type controllers, etc. Standardisation of components has been carried to a remarkable pitch of efficiency.

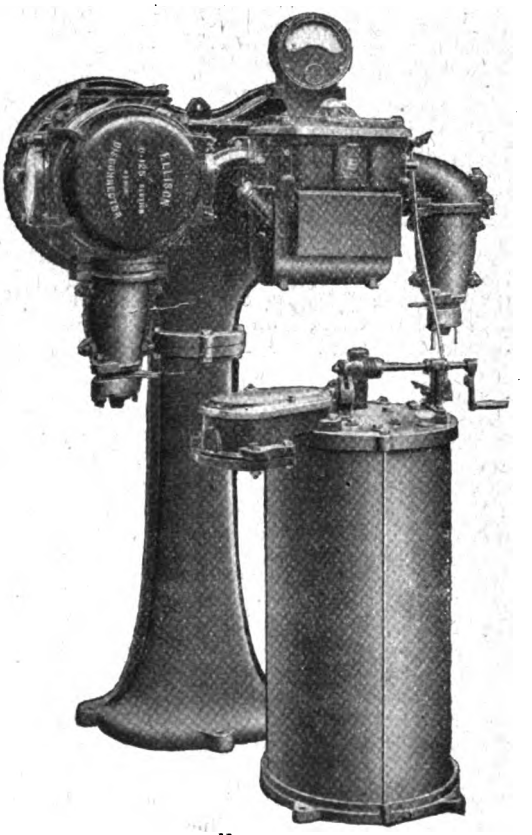


FIG. 1.

The control panels for induction motors with their independent component parts interlocked with each other, and satisfying the requirements of official regulations, are particularly suitable for use in works or factories. The breakers and starters have various interlocks, automatic features and mistake-proof operating handles, fulfilling industrial requirements better than apparatus assembled in one box or case. It is claimed that separated component parts facilitate inspection, repair and cleaning, and eliminate the possibility of danger in oil-immersed gear, when an arc is broken in hot oil, while the breakers remain cool under all conditions of load.

An auto-transformer starting panel for squirrel-cage motors up to 200 b.h.p. comprises an oil-break circuit breaker with automatic releases and time lags to give full protection and an auto-transformer in a separate oil tank, with connections to an oil-break change-over switch of the standard star-delta pattern. The change-over switch is fitted with the "Gradatim" device to ensure correct sequence and time in starting, and is mechanically interlocked with the circuit breaker. The transformer, being in use for the starting periods only, may be highly rated and allowed to heat to the safe limit of the materials, while the switch

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and circuit breaker remain cool always. Also the transformer tappings can be changed, or the transformer itself can be removed entirely when the plant is in service.

Fig. 1 shows an equipment for a slip-ring motor, comprising a circuit breaker and rotor starter mounted on a cast-iron pillar arranged in conjunction with a disconnector. The disconnectors provide a means of isolating sections of a plant or a single motor, for inspection and repairs; they are not intended to be operated when currents are flowing. The disconnector switch is housed in a circular box casting, with hinged cover, which can be disposed to connect up cables from any direction, and up to .3 sq. in. section. The live parts are mounted on insulated steel rods. The contacts are of a patent plunger and spring type, and the switch is operated by a handle inside the covers, which are padlocked. The disconnector is a useful individual piece of apparatus for sectionalising cable networks, and can be bolted to walls or installed in trenches.

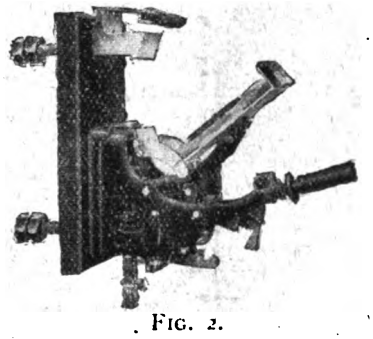


FIG. 2.

The oil cooled rotor starters are designed for starting slip-ring induction motors. They are weather-proof and dust-tight, and are suitable for use in all situations in works, mills, factories and mines. They control the rotor circuits only, and separate circuit breakers should be used for the stators.

Starters are built up to 1,500 b.h.p. and 1,000 amperes rotor current.

The contacts and resistance elements are submerged completely in oil. The contact dial is at the bottom of the tank under a very ample head of oil, and in the coolest part, eliminating danger, which otherwise might occur if the oil level falls. The complete starter can be removed bodily from the tank for inspection.

The moving contacts consist of heavy copper rollers, which are free to rotate and swivel on copper ball joints carried on a brass spider. They are forced against the fixed contacts by strong springs, so located that each roller is positively controlled and can surmount a roughness or obstacle on the dial without relieving the pressure on the others. The rollers are, therefore, self-seating and self-aligning.

The resistance element consists of a wire of high resistance alloy with negligible temperature co-efficient, wound on strong stoneware cylinders which support the wire throughout its length, and being threaded, effectually prevent short circuits from turn to turn.

A slow-motion device is fitted to the operating mechanism ensuring a quick movement from contact to contact, but with a pause at each contact.

In the oil-break circuit breakers, designed for industrial purposes, and specially suitable for use in factories, collieries and other places where dust and damp-proof apparatus is required, the breaker is contained in a massive cast-iron case and oil tank, jointed together by a grummet, so arranged that a stream of water may be directed upon it from a hose without risk of injury when the cable entrances are properly closed. All contacts are mounted on a slate, bushed and insulated with mica, and the brushes are operated by an insulated steel rod. The arcing joints are well submerged beneath the surface of the oil. The oil is poured in through a hole in an inclined boss on one side of the tank. The oil inlet is closed by a wood plug which acts as a relief vent if the pressure of oil rises unduly when heavy circuits are interrupted. The operating lever is a massive gun-metal handle, and a brass knob is provided on the cover for hand release. Series overload trip coils with time lags and other usual automatic releases are fitted as required. Fittings for connecting up all classes of cables are provided. The breaker can be mounted on a wall or on stands as part of a complete control equipment. All parts have been standardised for sizes up to 800 amps., double, triple or four-pole.

Totally enclosed air-break circuit breakers are made for use on supply mains, instead of house service switch fuses, and in mills, factories, workshops and non-gaseous mines, to control and protect distribution circuits, motors and kindred apparatus. Each breaker is provided with one "free" handle, which suffices for closing the circuit and for quick break hand release. Complete automatic releases, cable fittings and trailing cable plugs are mounted as required. There are two sizes, rated at 65 and 110 amps. respectively, and each can be single, double, triple or four-pole. Magnetic blow-outs can be fitted for D.C. The breakers are assembled in cast-iron boxes, which are dust and weatherproof. The current carrying parts are of ample section, and supported by insulated steel rods; breakable materials, such as marble, slate or porcelain are not used. Interlocks with other apparatus can be arranged and a remote release can be obtained.

The switchboard type air-break circuit breaker, shown in Fig. 2, are practically the same design as the breakers which were selected for use on the Paris tramway system in 1899, after severe competitive tests. Since then other supply authorities have subjected them to stringent tests, and the results have been completely satisfactory. The only alterations which have been found necessary in all this time are in details, in order to cheapen and simplify the manufacturing processes. The breakers are mounted on slate bases and are made up in numerous combinations of single, double, triple and four-pole patterns, with or without magnetic blow-outs, open type or with protecting covers. Every form of automatic feature is provided, and they can be supplied to satisfy any condition for which switchboard circuit breakers may be required. The exceptionally long carbon break and the simplicity of design are factors in the success of the breaker. There are six standard sizes, for currents ranging up to 3,500 amps. Finished parts are stocked to enable the works to supply promptly any of the 20,000 variants which are possible with the different sizes, types of handles, number of poles and automatic releases, blow-outs and covers, interlocks and contactors.

(To be continued.)

LONDON STUDENTS' SECTION INST. E.E.

The report for the last session shows that an average attendance at 11 meetings of 39 was attained. Full lists of the works visited, papers read and social functions held are included. Reference is also made to the summer tour to Glasgow last year and to the tour this year arranged for Switzerland.

On the occasion of the visit to the works of Messrs. Everett Edgcumbe & Co., Ltd., on Feb. 11, 1921, Major Edgcumbe offered two prizes for the best description of the works. The first prize, value £2 2s., was awarded to Mr. H. S. Petch, and the second prize, value £1 1s., was awarded to Mr. F. La T. Budgett.

The Council have decided to make a grant to the London Students' Sect. to cover the expenses of publishing advanced abstracts of papers for distribution to students before or at the meetings. The grant will cover the cost of producing about twelve such abstracts per annum. It is proposed to form a sub-committee to review students' papers and select those suitable for publication in abstract.

A very healthy and satisfactory report in all respects.

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BOSTOCK AND BRAMLEY CONCENTRIC SPEED TRANSFORMERS.

The concentric speed transformers, or self-contained reducing gear units, made by Bostock and Bramley (power transmission engineers, of Netherton, Huddersfield), are unique pieces of gearing which, after careful design and prolonged thorough testing, are now being produced commercially. The gear ratios obtainable

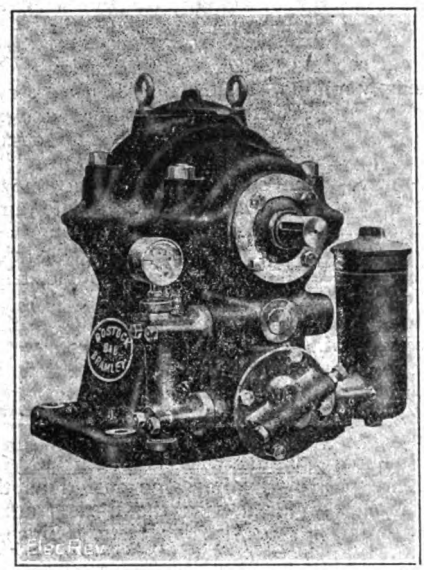


FIG. 1.

are from 3 to 1 up to 1,000 to 1 in single units. A general view of a unit is given in Fig. 1, and a sectional view in Fig. 2, and a view of the pinions in Fig. 3. Reference to Fig. 2 shows that the gear planets

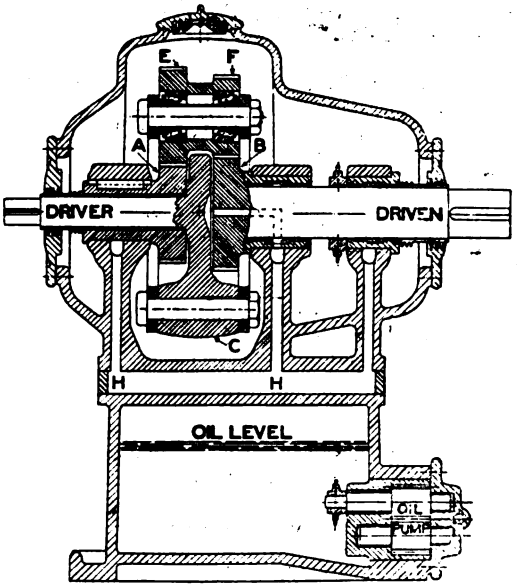


FIG. 2.

E and F are carried by heavy steel plates bolted to the driving member C. The planet E engages with the fixed sun wheel A, this member being rigidly keyed to the gear case casting. The planet F engages with the driven gear wheel B. All gears are made from high tensile heat-drilled steel, their teeth being cut by a generating process.

The planets E and F are in one piece, with no keyways or loose parts. Four sets of planetary gears are used for standard work, these being mounted on heavy type Timken roller bearings. The three main bearings are lubricated, under pressure, through the passages marked H, whilst oil is also forced, under pressure, on to the teeth of the gears. There is no splash lubrication and no power lost through the unnecessary churning of a bath of oil.

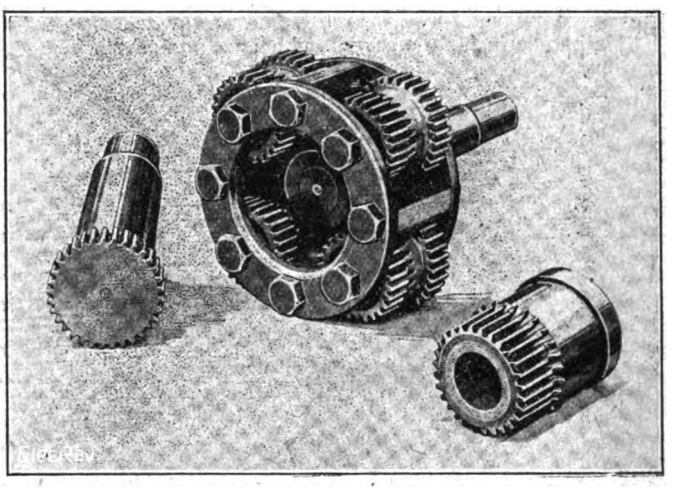


FIG. 3

As the power is evenly distributed round the circumference of the driving and driven members, the loads on the driving and driven shaft journals due to the thrust of the gears are neutralised. This type of gear unit also considerably reduces the face width of the gears and enables much finer pitches to be employed, which, in turn, lessen the amount of sliding between the teeth of the gears. The combined advantages of concentric speed transformers thus provide a silent and highly efficient form of power transmission.

The case (see Fig. 1) is designed on the unit principle. The main bearing caps are independent of the top cover, so that the latter can be easily removed, thus allowing of complete inspection of all parts. The planet pinions, Fig. 3, can be individually removed without disturbing the driving or driven shafts. The oil pump can be withdrawn as an independent unit, and is below the oil level, so that no priming is necessary. Slots are provided to allow of correct chain adjustment. The oil, during its circulation, is continually being filtered, the filler and filter also forming an independent unit. The unit is self-contained, and requires no attention beyond the addition of lubricating oil at rare intervals. The filter can be removed and cleaned whilst the gears are in motion.

It should be noted that the pitch diameters of ordinary spur gears vary directly according to the gear ratio, while, with concentric gearing, the larger the gear ratio the more closely do the pitch diameters approximate to each other. Concentric gearing possesses the great advantage of eliminating the drawbacks of small pinions and large wheels, giving at the same time a straight line drive.

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A train of Thought-

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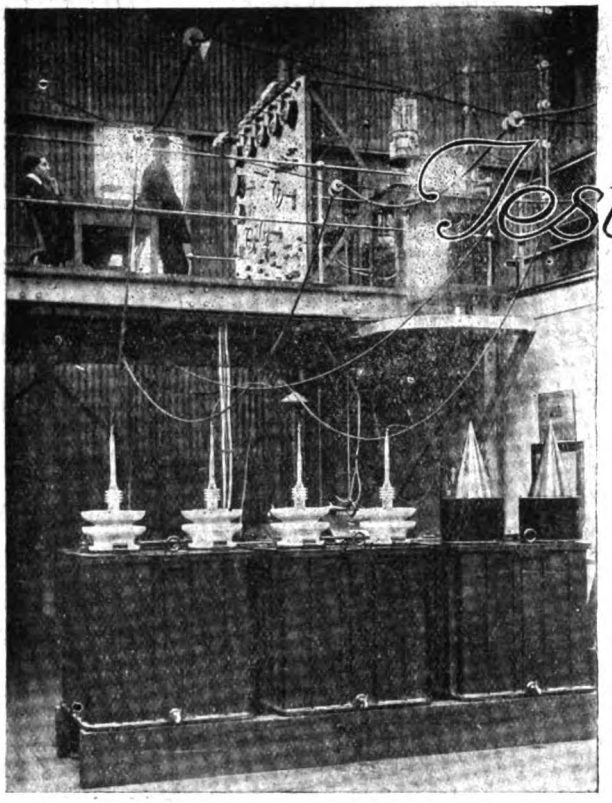
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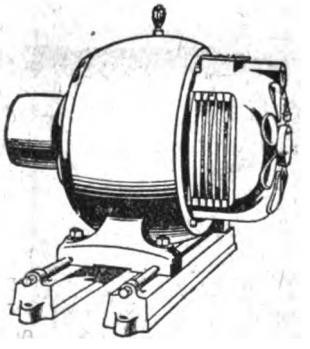
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 8s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Enterprise.

Congratulations to the Croydon Electricity Supply authorities upon their very enterprising activities in connection with the popularising of electricity for electric heating, cooking and other domestic duties. It is anomalous that the constitution of most of our electricity supply undertakings and the Parliamentary powers under which they supply electrical energy for public consumption are, generally speaking, at variance with the local electrical trade, which seeks to make a living out of the wiring of houses and the sale of current consuming devices of the description above referred to. The enterprising supply authority—and there are precious few in evidence in this country to-day—is always on the look-out for promising ways and means of adding to his station load, and thus decreasing the average generating costs per unit.

The electrical trader is similarly interested in pushing the sale of his wares, which in their turn enable the consumer to take full advantage of the facilities afforded by the current supplied by the local authority. Yet, although their interests are mutual and identical, the trader watches the supply authority as a cat watches a mouse, lest he encroach upon the sales field sacred to the retailer of current consuming devices—irons, kettles, fires, washing machines, vacuum cleaners and the like. There have been quite big fights in the past over this vexed question of the trading rights of a municipality, what time the unfortunate consumer looks on and wonders when the disputants will come to realise that it is in both their interests to cultivate his custom.

The usual plaint of the supply authority is that individual traders are not sufficiently enterprising; they are in too small a way of business, and do not always sell the best appliances for the job, thus bringing domestic electrical service into disrepute. Moreover, there is such keen competition between the various firms in a district that the public are confused, and frequently ill-advised, in regard to their purchases. The trader, on his part, alleges that the supply authority, in exploiting this trade, is cutting the ground from under his feet, whereas he contributes to the upkeep of the undertaking, where such is municipal, by paying rates. This petty bickering has been going on for years, when by well-considered co-operation between the two opposing factions, and co-ordination of their respective efforts, much might have been accomplished in the way of further popularising electricity.

Realising this weakness in the camp, the Croydon authorities have brought about a communion of interests by the formation of a subsidiary company in which the electrical dealers of the district participate by taking up shares. The Electricity Supply undertaking provides the necessary showroom, and affords facilities for sales of suitable appliances from a common stock, kept up by the various traders interested. Thus all work together for mutual benefit, the Electricity Supply people for a gratifying increase in their load, and the traders for a corresponding boom in the sales of their several commodities. It is an excellent example, which I commend to the notice of other districts as worthy of close imitation.

Games by Electric Light.

A few weeks back I commented on the possibilities of continuing some of our more popular recreations by the aid of electric light after daylight has failed us. In this connection it is interesting to note that strenuous games are not impossible after dark, even in the heart of the City. There has been established at the Great Eastern Hotel, Liverpool Street, a squash racquets court. The court is laid out on the roof of the hotel, is of regulation size, and is illuminated by electricity so that play can be continued at night. I have not personally inspected this installation nor tried the experiment of play by artificial illumination, and it would be interesting to have the views of any readers who have actually played under these conditions as to whether the results are satisfactory from the players' standpoint.

Our Telephones.

We have great hopes of reforms as an outcome of the deliberations and recommendations of the Select Committee on Telephones, but it is not altogether encouraging to learn from the lay Press that certain members of the Committee are adopting the ancient Post Office practice of going abroad to seek for telephone inspiration. Mr. Evelyn Cecil, M.P., chairman of the Select Committee, has just returned from a tour of investigation in Norway, Sweden and Denmark. Accompanied by a professional assessor, he is reported to have made a thorough examination of the telephone systems in Scandinavia, to determine whether they possess any features worth introducing here. The assessor will later visit the United States and Canada to study the systems in vogue there, and it is possible Mr. Evelyn Cecil will accompany him. It is sincerely to be hoped that these influential gentlemen will be duly advised of the fact that automatic telephony is an accomplished fact, and that they will be afforded an opportunity of inspecting some of the automatic installations in the last-named countries.

It has long since been pointed out that automatic switching represents the *ultima thule* in telephony, and even Sir William Noble has admitted that the British Post Office is giving it a fair trial in several public exchanges, so there must be something in it after all, especially taking into account the fact that America

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has enjoyed its benefits for upwards of thirty years already. Why do we always go abroad seeking much-needed reforms when the remedy is on our own doorsteps, and we have already satisfactorily experimented with trial doses? It is generally admitted by telephone engineers, and thoroughly borne out by public experience, that more than half our telephone troubles are directly attributable to the fallible human element. Eliminate that element, and you have considerably improved your service. The authorities cannot see this plain fact, and they still wobble over the time-worn excuse of greater prime cost, untried and experimental systems, etc., etc., what time they send out printed instructions to exasperated subscribers, telling them what to do when cut off in the middle of a conversation.

Ye gods! no experienced subscriber wants to be told what to do in such an emergency. He is too well accustomed to the experience, and lets loose his best Billingsgate to the admitted detriment of the operator's morale. And who can blame him? It is a confession of weakness for a State utility to circularise its patrons on such a matter; its first and foremost duty is to remove the disability under which telephone subscribers suffer, and not to tender them expert advice on the best means of imparting grumbles about a poor service to long-suffering telephone operators. I do not blame the operators; they are the victims of an effete system, which they are doing their best to work under very adverse conditions. How can a busy operator be expected to select the correct cord and plug for clearing every time from the jumbled mass of these conductors which obscures the average manual multiple jack field during the busy hour? It is asking too much of human nature; any reader who has witnessed the scene in a big exchange will recall its likeness to a jig-saw puzzle. It is essentially a job for carefully designed mechanism, and that is where the automatic telephone scores every time. Leeds, Portsmouth, Blackburn, Paisley, Accrington, Newport, Epsom, and other fortunate automatic telephone subscribers will endorse my remarks.

ELEKTRON.

SHOW-CASE AND WINDOW LIGHTING.

To meet the demand for a neat and effective lighting unit suitable for use in show-cases and windows which cannot be lighted from the top, the X-Ray Scoopette fitting has been designed. The Scoopette X-Ray reflector is a diminutive edition of the well known standard X-Ray reflector contained in a polished nickel or Florentine bronze casing with a bayonet lamp-holder. Two forms of casing are supplied, rectangular and elliptical, the same reflector being used in either case. The latter is shown in Fig. 1.

Any size of Mazda Navy Bulb lamp may be used in the Scoopette fitting. Navy Bulb Lamps are more efficient and durable than tubular lamps, and, in conjunction with Scoopette fittings, are very neat in appearance. Scoopette fittings are pre-eminently suitable for the lighting of jewellery, hosiery and other windows where close dressing is the almost invariable rule, and for the illumination of show-cases, small counters, pictures, music stands, typewriters, pianos, etc. Three brackets have been specially designed for use with Scoopette fittings. One is illustrated in

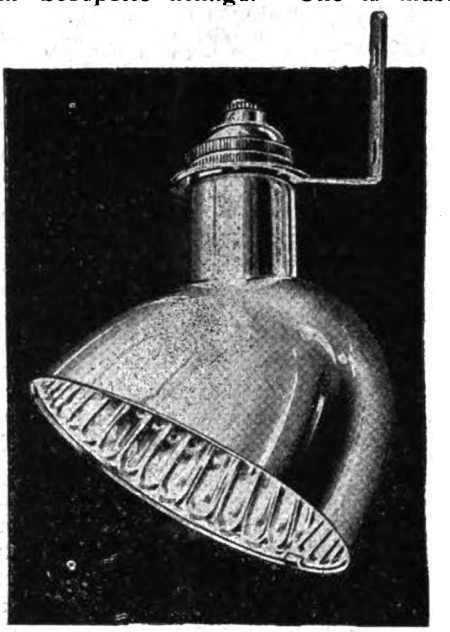


FIG. 1.
Scoopette Fitting.—Elliptical Pattern.

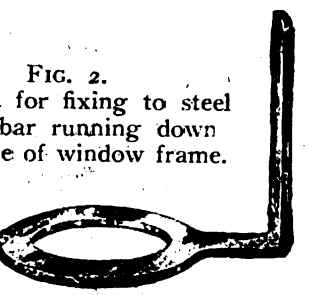


FIG. 2.
Bracket for fixing to steel tapped bar running down each side of window frame.

Fig. 2. Further particulars can be obtained from the British Thomson-Houston Co., Ltd. (Mazda House, 77, Upper Thames Street, E.C.4).

A WORTHY WAR MEMORIAL.

Of the countless local "war memorials," none is happier in conception than the Plaistow "Red Triangle" Club in Greengate Street, Plaistow. Recreation and technical training are provided for young and old of both sexes who live in the neighbourhood. The building is large, well designed and executed. There are five floors. Semi-indirect lighting has been largely adopted for club rooms, lounges and halls; G.E.C. fittings and "Superlux" glassware being used. The lighting of the swimming bath and gymnasium is by means of direct type steel reflector fittings of white vitreous enamelled steel. They are mounted at carefully calculated spacing and heights so that a practically uniform illumination of 3½ foot candles results. Osram vacuum and gasfilled lamps have been fitted throughout. The installation, which was planned by the Illuminating Engineering Dept. of the G.E.C., was carried out in a very workmanlike manner by Messrs. Coleby & Co., of 7a, Marylebone Passage, W.1.

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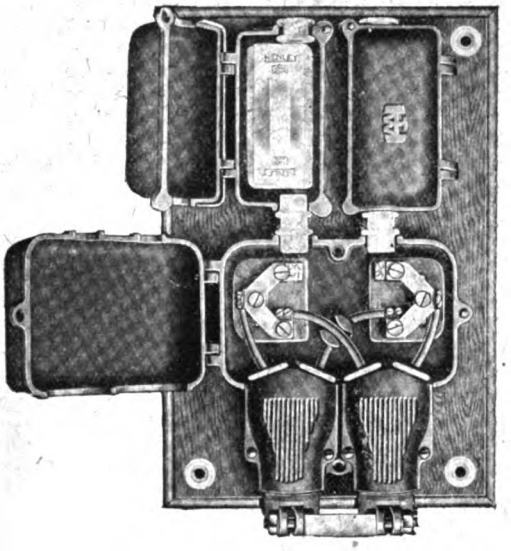
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HENLEY IRONCLAD SERVICE CUT-OUTS.

ISCO LOOP-IN MODELS.

An undertaking which has always required careful consideration and planning, viz., the installation of electricity into groups of houses and flats, is now a problem with many engineers. But the difficulties which are common to all these schemes revolve around the primary cost, i.e., the cost of installation. In fact the cost of opening up the ground and of materials have been factors which have caused the reconsideration of schemes in several instances.

Among the manufacturers who have turned their attention to the reduction of cost of installation is the firm of W. T. Henley's, who send us their new list of cut-outs. This will be found of practical interest to all engaged on the work, as it is apparent that they have carefully studied the main consideration, and we feel sure their range of Isco loop-in cut-outs will be of great service to engineers.



The cut-outs almost eliminate the use of joint-boxes and reduce the cost of "opening up" to a minimum. Practically any arrangement of feeding can be adopted, and each block of houses or flats, or number of blocks, can be fed by one supply cable or they can be fed from both ends. In the latter case (where the supply is tapped off either a three-wire or a three-phase four-wire main), by isolating a loop between two houses, one tapping can be taken off the positive side and the other off the negative side or off any phase and the neutral. They are provided with suitable cable entries, sealing chamber and fuses in one cast-iron case, and each consumer being directly connected to the main, provision for other circuits can be made. Provision is also made for taking a tapping through the party wall to the next consumer, and by a simple process of alternating the position of the links the balance of the system can be easily adjusted. Reference to the illustration, which shows the Isco 3, List No. 9639, mounted on a standard backboard with two 10-20 amp. s.p. cut-outs for two twin cables entering vertically, will serve to give a general idea of the principles involved.

Tappings can be taken off the Isco H cut-out for street lighting.

Armour grips are provided when desired, and the method of bonding the lead of the cable has received the experienced attention which the company usually pay to this important point.

A copy of the List (No. W.L. 2), which includes a four-page reproduction of blue prints, giving diagrams of cable connections, may be obtained from the Engineering Department, Henley's Telegraph Works Co., Ltd. (Blomfield Street, London Wall, E.C.2).

FINSBURY TECHNICAL COLLEGE OLD STUDENTS' ASSOCIATION.

The annual general meeting of the above association was held at the college on September 5, the President, Professor G. T. Morgan, O.B.E., in the chair. A report was read of the progress made since the association was resuscitated in the early part of 1920, and although space does not permit mention of all its activities we must refer to the great success of the dinner and smoking concert held last season.

The fact that the college is being kept open, and this due in no small measure to the individual and collective efforts of old students of the college, should impress on all old students the necessity of the association, and should ensure a steady influx of new members. Students who have recently completed their course are well advised to apply for membership at once if they have not already done so.

The annual dinner this year has been arranged for Saturday, November 12, and the smoking concert for Friday, January 27, both these functions being held at the newly-opened Engineers' Club.

The first number of a bulletin, which it is proposed to issue quarterly, is in course of preparation, and all old students are requested to forward immediately an account of what they are now doing for inclusion in same.

Application forms for membership and all particulars of the association may be obtained from the Hon. Secretary, H. P. Guy, 209, Northumberland Park, Tottenham, N.17.

BELFAST.

At the last monthly meeting of the City Council it was stated that the Electricity Committee had just received a report from the consultants, Messrs. Preece, Cardew and Rider, but they had not had time to consider it. It was agreed that a special meeting of the Council in Committee should meet on September 22 to consider it, together with all matters relating to the electricity station. The committee have decided to re-advertise for their switchgear requirements.

FACTORY AND WORKSHOP WELFARE.

The importance of adequate and correct lighting in factories and workshops is lucidly treated in Welfare Pamphlet No. 7, "Lighting in Factories and Workshops," issued by the Home Office. It is illustrated and contains in its twenty pages a wealth of information invaluable to every occupier of a factory or workshop, especially as the days are rapidly drawing-in and artificial light has to be resorted to for a considerable part of the working time. The well-known firm of Benjamin Electric, Ltd. (Brantwood Works, Tariff Road, Tottenham, N.17), who have specialised for many years in the manufacture of industrial lighting units for all purposes, and have studied in detail every requirement from the scientific, hygienic and commercial point of view, intimate that they will be pleased to send, gratis and post free, a copy of the pamphlet to any of our readers who are interested.

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CARRIER CURRENT TELEPHONY AND TELEGRAPHY.

(*Continued from page 494.*)

COMMERCIAL APPARATUS AND INSTALLATIONS.

Under this section there is given a description of the apparatus which has been developed for commercial service and of the manner of employing it in actual installations in the Bell Telephone plant. To date there have been developed and put into commercial use three distinct types of multiplex carrier systems, as follows:

1. A carrier-telephone system in which the carrier is transmitted.

2. A carrier-telephone system in which the carrier is suppressed.

3. A carrier-telegraph system.

There has also been developed a two-way repeater set employing vacuum tubes, and suitable for use with any one of these three systems.

The operation of the high-frequency side of the carrier-telegraph system will be clear from a consideration of the simplified telegraph circuit and from what has been said of the operation of the very similar carrier-telephone apparatus. It may be said, however, that the discrimination by tuned circuits between the sending and receiving channels which are of different frequencies is supplemented by a line-balancing arrangement. Referring to the operation of the low-frequency side of the system, it will be seen that the manipulation of the sending operator's key controls the sending relay of the carrier apparatus which in turn impresses the signals on the carrier current. In receiving, a sensitive polar-relay is used, operated by the rectified current, which in turn transmits the signals into the local subscriber's loop in the form of the usual direct-current impulses. In the actual apparatus, switches are provided by means of which the sending and receiving channels are associated with a common subscriber-loop for half-duplex operation.

The apparatus for one terminal of one full-duplex carrier-telegraph channel is mounted on a self-supporting rack. On the front of the panel are the vacuum tubes, the meters for observing the signalling currents, the sounders and key for monitoring, and the switches associated with the subscriber's loop circuit. The panel at the top is hinged to afford ready access to the apparatus mounted on the back. In the lower compartment are located the tuned circuits, including the adjustable condensers. Below these is the cylindrical case which contains the sensitive receiving polar-relay.

At the top of the testing unit is the relay and sounder of a regular test-wire which extends along the route taken by the carrier system, a meter for measuring high-frequency line currents and the dials associated with an oscillator for testing purposes. The jacks afford access to circuits of any of the carrier-telegraph panels grouped with the test unit.

General Considerations.—An important aspect of the carrier devolopments described is that they have placed the art upon a quantitative basis and enabled carrier installations to be engineered and put into operation in much the same way as is done for regular repeater telephone circuits. The transmission lay-out of the system is determined from a consideration of data on line characteristics and from the characteristics of the apparatus. In carrying out an installation a certain amount of preparatory work must usually be done on the lines, including particularly the loading of intermediate sections of cable, and transposition work. In the offices, the apparatus is installed in much the same way as are the more usual forms of telephone equipment, taking certain precautions, however, to minimise the lengths of office wiring included in the high-frequency circuits and to avoid crosstalk in the wiring interconnecting the individual apparatus units. The battery supply-currents for the vacuum tubes are usually furnished from the existing 24-volt telephone batteries and 120-volt Morse batteries.

The grade of service given by carrier circuits, both telephone and telegraph, is, as a rule, quite up to the high standard which prevails for the long-distance circuits of the Bell plant. Not only is it possible to deliver the volume of transmission necessary for enabling the carrier circuits to be greatly extended by the addition of ordinary circuits at the ends, but also the naturalness and intelligibility of transmission is preserved to a very satisfactory degree.

The carrier-telephone channels are terminated in the long-distance switchboards in the usual way. In fact, to the operators such circuits are indistinguishable from the regular long distance repeater circuits. The operator rings at the terminals of the connecting circuits in the standard manner, and the signals are automatically relayed over the carrier-telephone channel, so that each carrier-telephone channel is provided from end to end with its own signalling channel. The satisfactory working out of such operating features as these has been of much importance in completing the commercial usefulness of carrier-telephone systems.

As has been indicated, the carrier-telegraph systems as well as the carrier-telephone systems, are designed to fit as an integral unit into a comprehensive wire-plant, the relay-circuit arrangements providing for automatic repetition between the carrier channels and the connecting circuits, whether the latter be subscribers' loops or an additional section of long distance circuit. The carrier-telegraph circuits are used in the Bell plant, as are the regular composited Morse circuits, to furnish leased-wire service. The requirements for this service are particularly exacting as regards continuity and quality. The carrier-telegraph circuits have proved to be very satisfactory in meeting these demands.

Carrier-telephone systems at present are economical in a general public service communication system only for use over relatively long distances. The carrier-telegraph system is also essentially a long-distance proposition, although it is sometimes possible to warrant its use for distances somewhat shorter than in the case of telephone systems.

The authors state that the paper is based largely upon the results of the engineering and research work of a great number of engineers on the staff of Col. J. J. Carty, Vice-President of the American Telephone and Telegraph Company, and of Col. F. B. Jewett, Chief Engineer of the Western Electric Company.

(To be continued.)

ELECTRIC FURNACES.

A new catalogue describing the Wild-Barfield patent electric furnaces for the automatic hardening of carbon steel is just being issued by Automatic and Electric Furnaces, Ltd., 281-3, Gray's Inn Road, W.C.1. It is a particularly well prepared publication dealing concisely with the wide range of furnaces now manufactured. As furnace users are coming to realise the importance of adopting scientific methods of heat treatment, Automatic and Electric Furnaces, Ltd., are acting wisely in dealing so lucidly with their furnaces, which are all made with this principle to the fore. Heat Treatment Bulletin No. 29, which accompanies the catalogue, explains in simple language why the best results in hardened steel are obtained by hardening at the non-magnetic point. It should be invaluable to works employees. The company's device for indicating when this point is reached is known as the Pyroscopic Detector, and has been described in these columns, as has the Magnetic Scelometer—an apparatus for measuring the hardness of ferrous metals by a magnetic method. Both are also described in a comprehensive chapter on Electric Furnaces in the *Practical Electrician's Pocket Book and Diary* (Rentell, 3s. net).

Automatic and Electric Furnaces, Ltd., are exhibiting at the Engineering Exhibition at Olympia (Stand 97, Row E), where furnaces may be seen in operation.

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Do You Want To Be A Constructional Electrical Engineer?

There are more than enough Fitters, Linesmen, and "Electricians," but if you have the necessary skill to design and direct the construction of a dynamo—or other electrical machine—your services will be sought for—your career assured. One of the best books you can get on this subject is:

"SPECIFICATION AND DESIGN OF DYNAMO ELECTRIC MACHINERY."

By MILES WALKER, M.A., M.I.E.E.,

Professor of Electrical Engineering in the Faculty of Technology in the University of Manchester; Consulting Designer to Metropolitan-Vickers, Limited.

This book, which is as "full of information as an egg is full of meat," is undoubtedly *the* book to consult in difficulties that arise in connection with the subject of dynamo-electric machinery.

It is Officially Recommended to Students by the City and Guilds Examiners.

The plan adopted is to give sample performance specifications for machines intended for various classes of work. For each machine there is given a model performance specification and a design is drawn up to meet such specification in every particular The complete calculations of the machine are given in each case, and a specimen design sheet fully filled in reproduced in facsimile.

In order that the reader may follow the calculations, the first 250 pages are devoted to describing methods of calculating the various quantities of the magnetic circuits, the electric circuits, armature coils, and field coils, insulation and ventilation, and of predetermining the temperature rise. Special points, such as the determination of the regulation of an A.C. generator, or the paralleling of a synchronous machine, are dealt with in the second part of the book. All these methods of calculation are essentially

MODERN AND PRACTICAL.

CONTENTS:—Short rules for use in the design of Dynamo-Electric Machinery; Magnetic Circuit; The Materials of the Magnetic Circuit; Parts of the Magnetic Circuit; The Electric Circuits; The Design of Armature Coils and the Formers on which they are wound; Insulation; Ventilation; The Predetermination of Temperature Rise; The Specification and the Design to meet the Specification; Alternating-Current Generators—High-speed Engine type; Alternating-Current Generators—Slow-speed Engine type; Alternating Current Turbo-Generators; Induction Motors; Continuous-Current Generators; Rotary Converters; Phase Advancers: Index containing 3,000 entries.

533 ILLUSTRATIONS: a facsimile design-sheet and drawings of the essential parts are given for each machine worked out: 23 WORKING TABLES

Should you not desire to cut this copy, a letter to the same effect will serve.

A PURCHASER WRITES:—

Middlesboro:—

I received the book "Specification and Design of Dynamo Electric Machinery" quite safe, and after giving the contents a thorough searching examination have come to the conclusion that the book is all that could be desired as far as the construction of electrical machinery is concerned. It deals with the subject in a most emphatic way, elucidating all points that are liable to cause any difficulty. The mathematical formulæ are direct, the drawings clear and precise, and the tables and curves are easily understood.

BOOKLET FREE

To The Library Press Limited,

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Please send me full particulars of your special offer to readers of "Electricity" regarding "SPECIFICATION AND DESIGN OF DYNAMO-ELECTRIC MACHINERY," and free descriptive booklet.

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ELECTRICAL ENGINEERING—FINAL GRADE

Solutions to Questions set at the 1921 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page 473.*)

Q. 3.—A closed armature winding is rotated in a stationary heteropolar field system excited by continuous current. What is the difference in character between the pressure tapped off from points which are fixed relatively to the armature winding and the pressure tapped off from points which are fixed relatively to the field system?

Show that the action of a commutator machine is independent of the speed.

A. 3.—A heteropolar field system is that in which the poles are alternately *N* and *S*, this being in contrast to the homopolar field system in which each of the *N* and *S* poles is continuous around the whole periphery. Fig. 7 shows a closed armature winding—a ring winding being shown for simplicity—rotating in a counter-

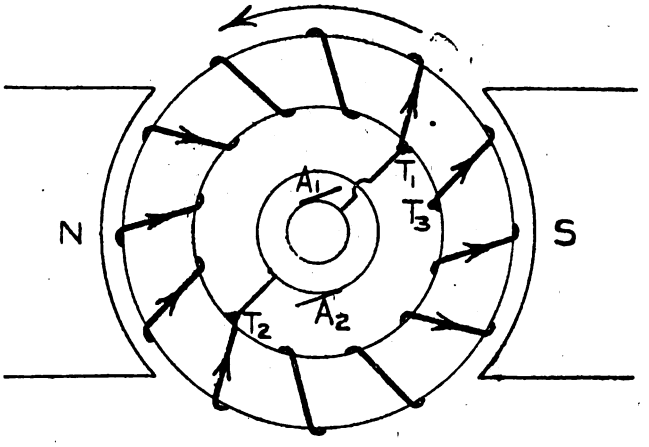


FIG. 7.

clockwise direction between two poles *N* and *S* excited by continuous current. T_1 and T_2 are two diametrically opposite points of the armature winding, and for convenience are shown connected to slip-rings on which brushes A_1 and A_2 are bearing. As the armature winding rotates in the magnetic field between *NS*, e.m.fs are induced in the directions indicated by the arrowheads.

When T_1 and T_2 are opposite the centres of *S* and *N* respectively, it is found that in *each* of the two armature circuits between T_2 and T_1 there are equal and opposite e.m.fs generated, so that the nett e.m.f. between T_2 and T_1 is zero. As the armature rotates from this position, more conductors generate e.m.fs acting from T_2 to T_1 and fewer conductors generate e.m.fs in the reverse direction, until when T_1 and T_2 are mid-way between the two poles, all the conductors moving under both the *N* and *S* poles are generating e.m.fs from T_2 to T_1; i.e., the slip-ring voltage is at its maximum, A_1 being positive relatively to A_2.

As the armature continues its motion, the voltage across the slip-rings decreases until when T_1 is opposite the centre of *N* and T_2 opposite the centre of *S*, the e.m.fs in each of the two parallel circuits between T_1 and T_2 are equal and opposite, and the slip-ring voltage is therefore passing through its zero value.

Further rotation of the armature increases the number of conductors generating e.m.fs from T_1 to T_2 and decreases those generating e.m.fs in the reverse direction, until when the tappings are again in the interpolar position, the slip-ring voltage is at its maximum, A_1 being this time negative relatively to A_2. During the next quarter of a revolution, the e.m.f. decreases to zero, and further rotation simply repeats the above cycle of changes in the value and in the direction of the voltage between tappings T_1 and T_2. With a 2-pole machine, this voltage alternates at a frequency equal to the number of revolutions per second, but its wave-shape is practically sinusoidal for a distributed winding of this type.

If the tappings, however, were taken at two points T_1 and T_3, one coil apart, the voltage across these two points would simply be the e.m.f. generated in that coil. From what has already been stated, it follows that this e.m.f. would be alternating; and if the coil-side were concentrated in one slot, the wave-shape would be indicative of the flux distribution round the periphery of the armature core, the e.m.f. at any instant being proportional to the flux density in the magnetic field through which the coil is passing at that instant. The further apart the tappings are taken, the nearer does the e.m.f. approach the sine wave.

Next, consider the voltage across points which are fixed relatively to the field magnets. As this can only be determined experimentally by connecting the armature winding to commutator segments insulated from one another, the latter have been introduced into Fig. 8. The question states neither the actual nor the relative positions of the two points to be considered, so we shall

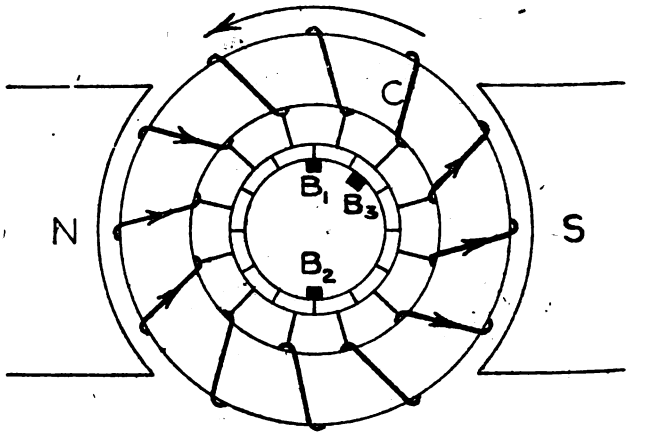


FIG. 8.

assume the usual one, namely B_1 and B_2 in Fig 8. Between these two brushes there are two armature circuits in parallel, each having the same number of conductors moving under the poles and therefore generating the same e.m.f. acting from B_2 to B_1, making the latter the positive brush. As the conductors move from under the poles, so others move to take their place, thus keeping practically constant the number of conductors actually cutting flux. The very slight variation from instant to instant in the number of conductors cutting the magnetic flux appears as a ripple on the voltage across B_1B_2 which can easily be detected by

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connecting a telephone receiver in series with a condenser across the brushes.

If the brushes be shifted round the commutator (sparking permitting), the voltage between B_1 and B_2 decreases until it becomes zero after a 90-deg. displacement. Further movement increases the P.D. between the brushes, but their polarity will be reversed.

If the two points in question be quite close together, say B_1 and B_3, the pressure between the latter is the e.m.f. generated in each coil in succession as the coils pass through position occupied by C in Fig. 8. This voltage is unidirectional but fluctuates over a wider range than that across B_1B_2. For a given armature speed, the e.m.f. generated in a coil is proportional to the flux density in the space where the coil is moving; hence by moving around the commutator two brushes fixed near to each other and measuring their P.D. for different positions, the distribution of the magnetic field can be determined.

From what has been stated above, it follows that the only effect of altering the speed of a machine fitted with a commutator, is to alter the value of the e.m.f. generated in each coil and therefore to alter the magnitude of the P.D. across the brushes. The number of conductors in each of the armature circuits remains unaltered so that neither the polarity of the brushes nor the steadiness of the voltage is affected; i.e., the action of the commutator is independent of the speed.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 124.

How would you find the direction of phase rotation on 2- and 3-phase systems? Is it possible to determine the direction of rotation of induction motors before switching on the current?—"S. H. ADAMS."

QUESTION No. 125.

How would you calculate the number of turns in the stator windings of an induction motor? It is presumed that a few of the factors are known, such as speed, voltage, frequency, etc.—"S. H. ADAMS."

(Replies to questions Nos. 124 and 125 must be received not later than September 24, 1921.)

Bradford.—In consequence of a threatened deficiency of between £30,000 and £40,000, the Electricity Committee have decided to recommend an increase in the price of current for industrial purposes.

Reviews of Books, &c.

[Books noticed in this column will be supplied by the ELECTRICITY Office to any part of the world at the published price, plus ten per cent. for postage. Customers' orders will be appreciated.

POWER FACTOR CORRECTION. By [illegible] man, 2s. 6d. net). Before [illegible] cial devices available for the [illegible] the author succeeds admirably [illegible] use on systems where the [illegible] bound to be where induction [illegible] if they are not running at full [illegible] explored and explained in a [illegible] mind that the object in view is to [illegible] reducing overhead charges at the [illegible] is also made as to whether the [illegible] undertaking should be responsible for [illegible] With this is bound up the question of [illegible] on power factor, and the author's fair [illegible] case should appeal to power users on A.C. [illegible] book undoubtedly fills a gap in technical [illegible] its appearance should be much appreciated.

MODERN CENTRAL STATIONS. By C. W. M[illegible] (Pitman, 2s. 6d. net). The brief description of the principal features of up-to-date British central station [illegible] contained in this "Primer" should serve to stimulate interest in young engineers engaged in any form of central station plant manufacture or operation. The whole question, including coal and ash handling plant, the boiler house, engine room, switch-gear, protective gear, testing and operation is lucidly and critically touched on and should surely give a touch of fascination to work which may easily become drudgery if not attacked, under sympathetic guidance with intelligence and zeal. On page 97 "thermal efficiency" has been printed for "efficiency ratio."

ELECTRIC MOTOR INSTALLATIONS. By F. H. Bullock, Managing Engineer, The Vulcan Boiler and General Insurance Co., Ltd. (Rentell, 2s. 6d. net.) It is stated that the company's statistics showed that over 11 per cent. of the motors in commercial operation break down each year. Many of these breakdowns are due to simple causes, and could, at small expense and with a little attention, be guarded against. The present manual has been prepared for the benefit of users and prospective users of motors, and indicates the class and type of motor to be installed in various cases, the attention required and the proper lay-out. As, therefore, the book is intended chiefly for those with little or no electrical knowledge, it has been written dealing with matters which may be regarded by many as obvious to all. Unfortunately, however, there are thousands of engineers, or in some cases people claiming the title, with no justification, who seem to think that because the electric motor is such a faithful servant it can be installed anyhow and then left practically to itself. It is scandalous that "85 per cent. of the breakdowns which occur are due to wear of bearings, presence of oil and dirt on the windings and commutator, and incorrect operation of starting appliances." But if first-class machines and fool-proof starters are used the troubles, even with inadequate attention, would be much reduced. The real remedy, however, is the education of all electrical plant users in the necessity for obtaining advice from competent persons as regards plant and lay-out, then to have it installed by competent contractors and to employ fully-qualified electricians to look after it. This excellently illustrated and clearly written manual will help in this direction.

THE MOTOR BOAT MANUAL. 178 pp. Temple Press, 8th Edition, 3s. net.) When a book reaches its eighth edition it is quite certain that whatever may have been said in criticism it fills a want. In this instance no pains have been spared to keep it abreast of the times, and we

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find that the design and construction of auxiliary yachts of all types, full-powered cabin cruisers and motor yachts, pleasue launches (open, or with day cabins), yachts, launches and motor dinghies, and racers are all fully treated. There is a very large number of illustrations and detailed sectional drawings, which, combined with fully descriptive letterpress, render the publication of the utmost value to all interested in motor-boats, even if of only a few horse-power. All details are considered, and we have no hesitation in recommending the book.

"MOTOR-CYCLES AND SIDECARS." By H. Corbishley. (Cassell. 1s. 6d. net.)—This is another of the excellent series of "Work" handbooks which Messrs. Cassell have made so famous, and the book now before us is a very well illustrated manual containing a large amount of eminently practical information of direct interest and value to the many thousands of motor-cycle owners in the country at the present time. We believe that there are over 100,000 motor-cycles actually on the roads in Great Britain, and there is no doubt that such a work as the one now under review will find a number of readers in such a wide field.

"SOUTH AFRICAN ENGINEERS' ELECTRICAL AND ALLIED TRADES DIRECTORY, 1921-22." (Argus South African Newspapers. 30s. net.)—The new edition of this very useful South African Directory shows sound evidence of the steady growth of the electrical industry in South Africa. It is, if anything, even more comprehensive than before. Several new features have been added and so much care has been taken in maintaining the accuracy of the contents that it will without doubt prove of the greatest possible use to firms in this country who may be anxious to develop their business with the great South African Union. This, of course, is quite apart from its immediate value to the South African engineers, architects, mining companies and others whose address and business are so faithfully recorded. It ought to find a place in the office of every electrical manufacturing firm who has any wish to improve its overseas trade.

Various Items.

Accrington.—The Electricity Commissioners have refused to sanction the application of the Corporation for borrowing powers for £126,850 for electricity extensions.

Bradford.—A new 12,000/15,000 kw. turbo-generator, said to be the largest at present running in Yorkshire, is expected to be in commission at the electricity works next month. The total generating capacity of the works will then be about 40,000 kw.

Coleraine, County Derry.—At the meeting of the Urban Council last week it was intimated that the Honourable Irish Society had very kindly consented to give the water-power at the Salmon Leap on the Bann, near Coleraine, to the U.C. at a nominal rent for the purpose of generating current for the electric power and lighting scheme of the Council.

Meeting.—Inst. of Production Engineers will meet on Sat., 17th inst., at the Inst. of Mech. Engrs., Storey's Gate, at 7 p.m. Mr. J. D. Scaife, Member of Council, and Works Manager of Messrs. Ransome & Marles Bearing Co., Ltd., Newark-on-Trent, will deliver a paper on "The Manufacture of Ball and Roller Bearings," illustrated by lantern slides. All interested are cordially invited to attend.

Blackburn.—The T.C. has approved a scheme for the supply of electricity to the districts of Rishton, Great Horwood, Wiltshire, Clayton-le-Dale, and Ramsgreave, and authorised an application to the Commissioners for a special Order together with powers to sell electric fittings and apparatus. Alderman Kenyon protested against the inclusion of the latter part, but the Town Clerk said these powers had been possessed by the Council over twenty years.

Electricity Supply.—It was hoped to establish a voluntary joint electricity undertaking for the Mid-Lancs area, the idea being to erect three generating stations to cover the districts of Blackburn, Blackpool, Burnley, Preston, Accrington, Bacup, Colne, Darwen, Haslingden, Nelson, Lytham, St. Anne's, Fleetwood, Rawtenstall and Brierfield. It has now been decided to postpone the scheme *sine die* in view of the gigantic financial obligations which it would involve. The Electricity Commissioners will therefore probably have to devise a scheme for the district.

Trade Notes.

We are informed by the **Jackson Electric Stove Co., Ltd.**, that the address of their Scottish Agency is 68, Gordon Street, Glasgow, and not 68, Gordon Road. The Agent is Mr. Kirby Johnson.

"Z" Electric Lamp & Supplies Co., Ltd. (73, Newman Street, W.1), are offering the present model of the "Electrolux" Portable Cleaning Apparatus at specially advantageous terms to the Trade.

R. A. Lister & Co., Ltd. (Dursley; Glos.), are issuing particulars of the "Lister" petrol, oil and gas engines, and of the new "Lister" Dynamo, 55/75 volts, 14 amps., 1,900 r.p.m. The engines range in h.p. from 2 to 12.

Charles Selz (83, George Street, Portman Square, W.1), actual maker of every kind of Silk Shade for the Wholesale and Export Trade, sends a catalogue which contains illustrations of Silk Shades in surprising variety, there being a number of new designs, which may be seen at the showrooms.

A leaflet from **General and Electrical Repairs Co.** (Hill Street, Park Street, Bristol), refers to the Humphry "Surshield" renewable enclosed cartridge fuse made by them in sizes 0-200 amp., 600 volts. The cases are filled with a powdered agent which readily fluxes with the metallic oxides at the temperature of the molten fuse wire.

We have received from **R. B. Hodgson & Co. (Sheffield), Ltd.** (Sentinel Steel Works, Sheffield), a 40-page catalogue dealing fully with "Pinnacle" Steels for machine tools. Particulars are given of the various "Pinnacle" Steels together with the purposes for which they can be used. Valuable information on heat treatment is given, while the Steel and Tool Reference will be found most handy. Altogether the catalogue forms a most useful publication.

Millns Electrical Co., who are the sole London Agents for the heating and cooking apparatus manufactured by the Arora Co. of Loughborough, have been appointed sole selling agents for Great Britain and the Colonies by G. Meidinger & Co., of Basle. The manufactures of this company include A.C. and D.C. motors up to about 300 h.p., generators, all classes of blowing equipment, transformers, starters and control gear, etc. The address of the Millns Elec. Co. is 17, Whitefriars Street, E.C. 4.

The September issue of the monthly magazine of **Higgs Bros.** (Sand Pits, Birmingham) continues the little article on Motor Starting Gear, referring especially to squirrel cage motors up to 3 h.p. and motors with wound rotors. In addition to the usual humorous notes and illustrations, reference is made to the specification and price list of Higgs' motors (either or both of which will be sent willingly on application) and to the recosting of the machines whereby reduced prices are offered. There is also, of course, the monthly stock list.

Harwell, Ltd. (2, Bayley Street, Tottenham Court Road, W.C.1), advise us that they are the sole agents in this country for the well-known firm of Usines Dielectriques, Delle, Territoire de Belfort, France, who have the most up-to-date works for the manufacture of micanite, amberite, oil silk, paper, sheets, tapes and cloths, all classes of insulating varnishes, and also commutator rings, presspan and Bakerlite material. The Company further intimate that they will be very pleased to send samples and prices to any of our readers who are interested.



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ELECTRICITY
A PRACTICAL TRADE JOURNAL

SEPTEMBER 25, 1921.

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ACCURATE SPEED MEASUREMENT.

Accuracy in the measurement of the speed of rotation of machinery is always desirable and often essential. Accuracy cannot, however, be relied on if speed measurement is made by means of speed counter or mechanical tachometer—at any rate, not in the case of relatively small machines. For one thing, the additional friction introduced often very seriously reduces the speed. The device known as the stroboscopic vibrator is especially useful for those cases in which the speed has to be held at a given value and in which acceleration has to be measured. It consumes no

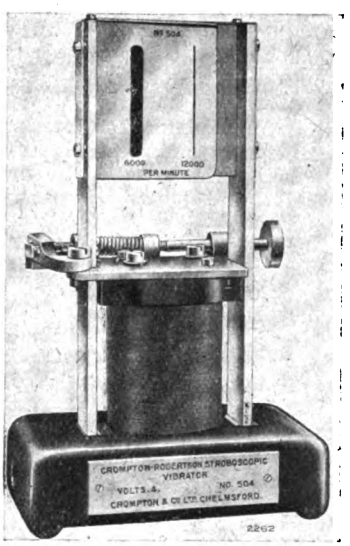


FIG. 1.—CROMPTON-ROBERTSON STROBOSCOPIC VIBRATOR.

power from the shaft being tested, and gives a continuous indication with equal accuracy at high or low speeds, there being no errors due to inertia or hunting.

The vibrator (Fig. 1), designed by Professor David Robertson, of the Merchant Venturers' Technical College, Bristol, has two similar vibrating bars clamped into a cast-iron base, which forms the electromagnet, by which their movement is maintained. The motion of one of the bars interrupts the circuit of the electromagnet coil at the right point in each cycle, in the same manner as the contact of an ordinary electric bell. The form of clamp is such as will permit the removal and replacement of the bars without alteration of calibration, in order that bars of a different frequency may be used when desired. The whole apparatus is simple and robust; it can be easily repaired in the laboratory without any special skill, and without changing the calibration. The only part likely to require attention occasionally is the platinum contact, whose renewal costs much less than the upkeep of an ordinary stop-watch. To each bar is attached an aluminium screen or "wing."

There are two slits in the front wing through which vision is permitted at definite points in each cycle. One of these is for "edge" vision, giving a glimpse frequency equal to that of the bars, and the other for "slit" vision, giving twice that frequency.

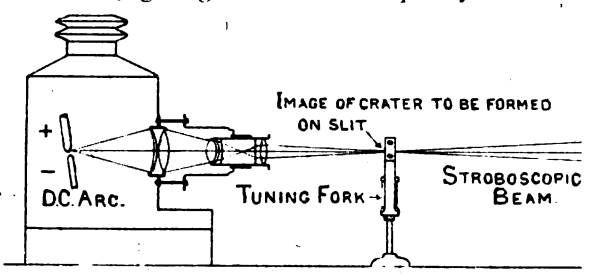


FIG. 2.—PRODUCTION OF A STROBOSCOPIC BEAM BY A VIBRATOR.

With "edge" vision the path is normally closed, but is opened when the displacement is great enough in one direction. For "slit" vision, slits in the two wings are exactly opposite to one another when the bars are at rest, but the path is closed when the displacement of each bar is half the slit width. It will be seen that edge vision gives an opening at each extreme of positive displacement, while slit vision gives one each time the bars pass their equilibrium position. Consequently, with edge vision the frequency of the glimpses is the same as that of the bar, but with slit vision it is twice as much. As the wings are arranged either frequency may be employed, but slit vision is generally to be preferred, as it gives better images owing to the sharper cut-off.

The vibrating shutter may be held close to the eye, so as to permit intermittent glimpses of a pattern marked on some revolving part of the machine under test. For constant-speed work this is very satisfactory, but for the running-down test it is much better to project the light from an arc lamp through the slit on to the stroboscopic disc. The changes of speed can then be seen from any point, and can be followed by any number of persons at once. Fig. 2 shows how this can be conveniently done with an ordinary projecting lantern.

The pattern consists of a number of equally spaced spots or marks on the pulley or on a card fixed to the shaft. Let the speed be such that during the interval between the centres of successive glimpses the marks move exactly one place forward. Each spot will then be in the position which was occupied at the previous

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glimpse by the one ahead, but owing to the persistence of the impression on the eye and to the fact that all the marks are similar, it will seem as if no motion has taken place. The result is that the whole set can be seen, although they are actually in rapid motion, and they appear to be stationary. This may be termed the "primary speed," to distinguish it from the other synchronous speeds referred to below. The motion of the spots during the time the glimpse lasts causes a certain amount of drawing out and loss of distinctness of the images, but this can be reduced as much as desired, at the expense of brightness, by cutting down the duration of the opening. Should the speed be a little over synchronism, the spots will reach a little further than the next place by the second glimpse, but the same causes which formerly made them appear to be stationary will now give the eye the impression that each has only moved a distance equal to the excess of their motion over their pitch. The result is that the whole set is seen moving slowly forward with a velocity equal to the excess of their speed above synchronism. In the same way, should the speed be a trifle low, the pattern will appear to be moving backwards with a speed equal to the difference from synchronism.

When running at twice the primary speed, the motion during the glimpse period is twice the pitch, and at the second glimpse each mark is exactly at the place formerly occupied by the second one ahead. They consequently appear to be steady, but the definition is not so good as at the primary speed, because the movement during the time of vision is twice as great. In the same way as before, the pattern seems to move forward when the speed is too high, and backward when it is too low. The slip frequency is twice as great as formerly, and corresponds to a glimpse frequency of twice the actual value. Similarly also for other multiple speeds, while stationary patterns are also observed when the speed is a submultiple of the primary speed. Thus at half primary speed the spots move only half a pitch during the glimpse period. The pattern is thus seen in the same position at every other glimpse, the images formed at the even glimpses being midway between those formed at the odd ones. The two sets of images are superimposed, and the result is again a stationary pattern, but the number of marks seen is twice the actual number. Fig. 3 shows a disc with a Gothic-tooth pattern as it appears at different speeds. This pattern has been found the best in use.

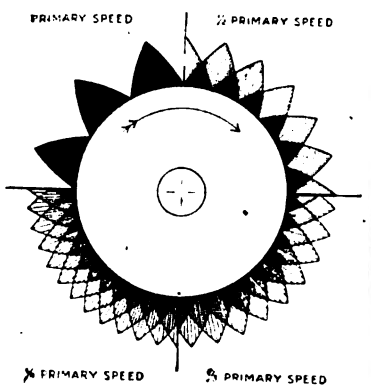


FIG. 3.—OVERLAPPING OF GOTHIC TEETH AT SUB-MULTIPLES OF PRIMARY SPEED

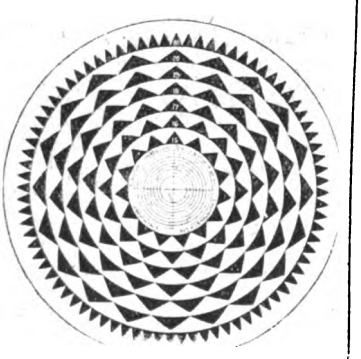


FIG. 4.—SEVEN-RING STROBOSCOPIC DISC.

Fig. 4 shows a disc to give a large number of speeds. The speed table for this disc is given in Leaflet 753, issued by the manufacturers, Crompton and Co., Ltd. (Chelmsford), who also give other useful information about this device.

THE ENGINEERING EXHIBITION.

(*Continued from page* 510.)

The Lea Recorder Co., Ltd. (Stand 34, Row B), are showing in operation their coal meters, boiler feed measures, the Standard Lea recorder, etc. These devices all tend to economy and efficiency in engine room by enabling difficult but important measurements to be easily made. The coal meters can be fitted in almost any position relative to the chain grate and automatically count up the coal consumed irrespective of speed of grate or thickness of fire. The boiler feed measurer shown has a capacity of 30,000 lb. per hour. The apparatus can be fixed in the pipe-line between an overhead storage tank or water supply, and the feed pumps. The flow through the V-notch is automatically controlled by means of an equilibrium valve and float in accordance with the demands of the feed pump, so that the hot well end of the tank is kept full of water at all times. The Standard Lea recorder measures the flow of water over a rectangular weir, and illustrates the application of these machines for the measurement of large volumes of water, such as water supply, streams, sewage, etc. An interesting experimental weighing apparatus designed to demonstrate that a cubic foot of large coal weighs exactly the same as a cubic foot of small coal is also shown.

At Stand 42, Row B, information can be obtained from the builders, Swan, Hunter and Wigham Richardson, Ltd., about the "Trade Ship"—a vessel of over 20,000 tons with eight decks, on four of which a travelling exhibition will be housed for a world tour when the ship is ready. The Company embarking in this enterprise is the British Trade Ship, Ltd., 12, Grosvenor Gardens, S.W.1.

The Heemof Co. (Holland), for whom Wiliams, Pell and Baring are London agents, show a wide variety of electrical appliances on Stand 47, Row C. Included are items of switchgear of all kinds, a rectifier made to give 1.5 up to 6 amps, D.C. motors, transformers, automatic synchroniser, and automatic voltage regulator for A.C. generators.

The Sunderland Forge and Engineering Co. (Stand 50, Row C) have a very instructive exhibit embracing generators and motors, besides a worm geared winch to lift three tons at 100 ft. per min., and lighter loads at faster speeds. It is fitted with watertight motor of 35 b.h.p., and controlled by contactor type gear, with master controller fitted on motor. This winch is for use on board ship. A spur geared winch, for use in shipyards, etc., to lift three tons at 60 ft. per min., fitted with weatherproof motor of 22 b.h.p., and controlled by a hand-operated drum controller, is also shown, as is a worm and spur geared winch, to lift three tons at 45 ft. per min., and fitted with weatherproof D.C. motor of 18 b.h.p., and operated by a special drum-type controller eliminating all resistances.

On Stand 52, Row C, S. G. Brown, Ltd., show radio and loud-speaking telephones and various electrical and cable instruments, also the "Cyclux" cycle lighting set. The A.C. generator is simple in design and substantially made. It is driven off the wheel rim.

Medway's Safety Lift Co., Ltd., show various lifts in operation on Stand 55, Row C.

Small generating sets are shown by Parsons Motor Co., Ltd., on Stand 71, Row D, while on Stand 72, Row D, Bercley and Young, Ltd., B.K.B. Elec. Motors, Ltd., the New British Elec. Supply Co., Ltd., and the Magnoid Co., Ltd., are exhibiting "Bandy" fans, "Bandy" single-phase A.C. repulsion, and repulsion-induction motors, B.K.B. and featherweight types of small motors from 1/100 to 2 h.p., "Emcol," T.E. motors, and various accessories for welding,

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motor-car and engineering. (Particulars of the B.K.B. and "Emcol" motors are forming the subject of a separate article in ELECTRICITY.)

The Aster Engineering Co. (1913), Ltd., show several generating sets, in which the prime mover is a semi-Diesel petrol or paraffin engine, on Stand 78, Row D, and on Stand 188, Row K, the "Aster British" Light" semi-automatic plant. At the next stand John I. Thornycroft and Co., Ltd., have an instructive engine exhibit.

Fittings, switchgear, etc., for shipwork especially may be inspected on Stand 82, Row D—Wm. McGeoch and Co., Ltd.—and at the next stand Campbell and Isherwood, Ltd., show generating sets, motors, electric drills, pumps, switchboards, etc., all particularly designed to meet the requirements of ship work. We next come to Babcock and Willcox, Ltd., the universally-known boiler experts, while, at Stand 132, Row G., John Thompson, Ltd., exhibit samples of their renowned boilers. Clarke, Chapman and Co., Ltd. (Stand 86, Row E, and 169, Row J), also have a show of heavy engineering and electrical plant for ship and shipyard work.

Those interested in oil engines and internal combustion engines driven by small electric generating plants should not miss Stand 95, Row E, which is occupied by Norris, Henty and Gardners, Ltd. At the next stand Pooley and Austin also show similar plant, Maudsley's dynamos, motors, etc., switchgear by the Park Royal Engineering Works, Ltd., and samples of various wires and cables made by the Greengate and Irwell Rubber Co.

Scholey and Co., Ltd. (Stand 98a, Row E), show their fractional h.p. motors for D.C. and A.C., 1/50 to ½ h.p., "Kutmore" portable electric drills, the "Croydon" electric suctor and blower, and the "Croydon" domestic suction cleaner, as well as "Copes" boiler feed water regulator.

Besides the various examples of gears for large powers, the Power Plant Co., Ltd. (Stand 123, Row F), show a 500 h.p. magnetic clutch, coupling and brake combined. This is mounted up so that it can be operated electrically, and when the clutch declutches the brake simultaneously comes into operation, thus ensuring immediate stoppage of the machinery in case of necessity.

The Cambridge and Paul Instrument Co., Ltd. (Stand 134, Row G), show new electrical CO_2 recorders, distance thermometers and resistance pyrometers among their many other instruments. CO_2 indicators are also shown on Stand 143, Row G, by W. R. Patents, Ltd.

The Electro-Mechanical Brake Co., Ltd. (Stand 144, Row H), make a big display of the "E.M.B." unbreakable, jointless and rustless grid resistances, and show examples of motor starters, controllers, etc., in which these resistances are used.

On Stand 156, Row H, the Fairless Engineering Supplies Co., Ltd., and Engineering and Lighting Equipment Co., Ltd., show cargo clusters, deck and engine-room fittings for general ship use, fitted with patented "Anti-break" discs. Various fittings for street, dock, etc., use, arc lamps, colour matching arc lamps, and fittings for gasfilled lamps. Also a rack for engineering stores.

Among the exhibits by Boulton and Paul, Ltd. (Stands 159, Row J, and 348, Gallery), are pumps, liquid elevators, and "Electrolite" houselighting sets.

Mark Webber, Ltd. (Stand 174, Row K), show a full range of "Webber" engines designed by Mr. H. R. Ricardo. Among the engine-driven generating sets is a welding set for single operator. In addition many appliances, including cookers, fires, vacuum cleaners, kettles, etc., are shown running off the sets.

Coming to Stand 180, Row K, we find an exhibit by the Rawlplug Co., Ltd., who, as many readers are aware, are manufacturers of a patent fibre plug which obviates the difficulties previously encountered in securing a firm fixing into any material. By the use of these plugs, fastenings can be accomplished with great efficiency. By means of the steel Rawlplug tool and bit, a hole can be made the exact size required, and then the fibre Rawlplug is pushed into position ready to receive the screw, the plug automatically expands as the screw is turned home, thus ensuring a perfectly firm fixing. It is a labour and time saving method, and results in a neat job, the Rawlplug being invisible when in position. Rawlplugs are made in all sizes and lengths for use with any screw. The exhibit includes some splendid examples of how the plugs can be used to advantage in different materials. From the electrical point of view there is a wide choice of features. There are shown wiring systems fixed with Rawlplugs, switchboard fittings, fittings on polished slate, electric light fittings on glass and marble, and numerous other examples on concrete, cement, brick, plaster and metal. The cold storage and lavatory accommodation applications shown on tiles are well worthy of note, and especially deserving in view of the difficulty of fitting in these materials in the past. Continuous demonstrations and advice on the adaptability of Rawlplugs in any material are given to show how easily they can be manipulated.

The Record Engineering Co., Ltd. (Stand 183, Row K), have on view four examples of "Record" and "Silent Record" internal combustion engines, two driving electric generators. At the next stand, Stuart Turner, Ltd., show a .5 kw. semi-automatic house lighting set and a 1.5 kw. set. Stands 204/5, Row K., are devoted to a selection of excellent electrical tramway and railway material of various kinds as made by Brecknell, Munro and Rogers, Ltd., for whom the sole selling agents are the Peckham Truck and Engineering Co. Dieny and Lucas (Stands 230-1, Gallery), have a varied selection of electric drilling and grinding machines, fractional h.p. motors, fans, a new automatic lathe and other interesting items.

The Harper Piano Co., Ltd. (Stand 258, Gallery), include in their display an example of the Harper electric piano and Harper singing birds—a novelty giving a reproduction of the singing either of a canary, nightingale, blackbird, etc.

Edison Accumulators, Ltd. (Stand 293, Gallery), have an exhibit which consists of a number of Edison accumulators ranging in capacity from 1.5 to 450 ampere hours, and varying in application from wireless "valve circuits" to the propulsion of five-ton electric vehicles.

Besides electric drills and small grinders, The Consolidated Pneumatic Tool Co., Ltd., show on Stand 363a, Gallery, an electric lifting block, besides pneumatic hammers for riveting, caulking, chipping, etc. A hammer is shown in section.

On Stand 360, Gallery, the London Elec. Wire Co., and Smith's, Ltd., show examples of their manufactures. The company specialise in wires insulated with silk, cotton and enamel for armature, magnet and coil winding, and in high resistance alloys for electric starting and heating apparatus. They also make a speciality of urgent ship and colliery repair work.

All cables and wires supplied for electric power and lighting purposes are made to the standards of the C.M.A., of which the company are members. The Salford Branch (Messrs. Frederick Smith and Co.) manufacture high conductivity copper wires and strips, special non-fouling trolley wire, phosphor and silicum bronze wires, etc.

Electric furnaces are shown on Stand 97, Row E, by Automatic and Electric Furnaces, Ltd., as referred to in the last issue of ELECTRICITY, and on Stand 186, Row K, the Patent "Lecfur" furnaces made by the Leeds Electrical Construction Co., Ltd., may be seen, as may also "Lecfur" automatic electric rivet heaters. In the latter case the rivets are fed through a resistance furnace of cylindrical form which is rotated by a motor at any desired speed, within limits, to give the required output per minute. A thermostat and circuit breaker can be supplied to control the temperature. The rivets are fed into the furnace with the shank end foremost, and are automatically discharged at the other end of the furnace at the correct temperature for riveting. In the event of the rivet being fed into the

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furnace with the head instead of shank foremost, it is automatically discharged at the feed end of the furnace, making the apparatus fool-proof against incorrect feeding. Rivets smaller in diameter than the maximum size for which the furnace is constructed are automatically heated and discharged at a proportionately increased output, although the speed of rotation of the furnace may remain constant. The time taken for a rivet to travel through the furnace is dependent on the speed of rotation, the size of the rivet, and the ratio between the length and diameter of the rivet. As an example, when heating rivets of the same diameter but of unequal length, the heavier rivet takes a longer period to travel through the furnace, thus automatically obtaining the longer time element required for heating a larger mass of metal to the same temperature, and *vice versa* when heating smaller rivets. The furnaces for the melting of non-ferrous metals, heat treatment of carbon and alloy steels, tubular furnaces etc., possess many valuable features and will repay examination and investigation. On Stands 200-1, Row K, Handcock and Co. (Engineers), Ltd., show a small tool-room furnace in which a temperature of 2,500°C. can be attained.

The progress made in the art of electric welding may be well studied at the stands of various firms specialising in this important recent development, e.g., at Stand 3, Row A, G. D. Peters and Co., Ltd., demonstrate their latest methods of arc welding, while at Stand 6, Row A., Alloy Welding Processes, Ltd., show three distinct types of equipment in operation. There is a light, self-contained, portable petrol driven arc welding set and a motor generator set, designed especially for tramway engineers. In both cases the plant and instruments are totally enclosed so as to enable them to be used in the open. An A.C. welder, working at the low voltage of 50 is also on view. The Premier Elec. Welding Co., Ltd. (Stand 30, Row B), are demonstrating both arc and resistance welding. The plants exhibited are of the single-operator type the engine-driven plant consisting of a 4.4 kw. generator driven by a 10 h.p. internal combustion engine, and complete with exciter, reactance, switchboard and all necessary fittings. The motor generator set is of a generally similar design, but driven by a 7½ h.p. motor. The company claim that the special design of this plant has entirely done away with the use of series resistances in the welding circuit. Samples of the latest types of "Premier" electrodes are exhibited, these including the following: General Service, for the welding of mild steel, wrought iron, cast iron, etc.; High Carbon, for use where a hard metal deposit is required; Manganese Steel, suitable for the welding of tramway points and crossings.

British Arc Welding Co., Ltd. (Stand 63, Row C), show some remarkable strong welds which they have made and which have been subjected to severe tests. A welded pressure vessel, 12¾ in. external diameter, made from ⅜ in. ship plate is shown, which has withstood a pressure of 4,500 lb. per square inch. A large weld in 11/16 in. boiler plate was made successfully with the two sections securely riveted to an angle framework, and this interesting weld of an absolutely rigid structure is exhibited. Other specimens show the mechanical behaviour of arc welds made by the firm under various mechanical tests which will interest all concerned with engineering.

Electric welders, butt and spot, are seen in operation in the display made by Perkin and Co., Ltd. (Stand 100, Row E.) and in a wide range of welding plant by Buckley, Saunders and Co., Ltd. (Stand 104, Row E.), there is included a universal welder for spot, butt or press welding. In this machine the transformer is arranged to be of ample capacity without overheating, and the toggle movement gives the required pressure at the weld. A fixed or movable switch is fitted, with automatic cut-off where advisable. It is made in sizes up to 100 kw. and is an invaluable machine where it is desired to do various classes of work on one welder, as the different blocks and electrodes can be rapidly changed. Water cooling to blocks and electrodes is fitted in all cases. Another exhibit is an electrical rivet heater for heating up to 1,100 small rivets per hour, and less with larger rivets. Other sizes of machines are made.

Other resistance welding machines for spot, seam and butt welding are shown in a comprehensive exhibit by the A.1. Mnfg. Coy., whose stand (162, Row J) is in part welded.

Electric trucks for industrial use are represented by the manufactures of H. C. Slingsby (Stand 101, Row E), British Elec. Vehicles, Ltd. (Stand 106, Row E), W. Goodyear and Sons, Ltd. (Stand 141a, Row G).

Various items of wireless equipment of large or small power and embodying various individual improvements in design and construction may be seen on Stand 12, Row A, Wm. Hamilton Wilson; Stand 14, Row A, Radio Communication Co., Ltd.; Stand 52, Row C, S. G. Brown, Ltd.; Stand 135, Row G, R. M. Radio, Ltd.; Stand 179, Row K, F. O. Read and Co., Ltd. (amateur wireless).

On Stand 168, Row J, the De Laval Steam Turbine Co. have a 10 b.h.p. De Laval single stage steam turbine connected to a 2 kw. H.F. alternator and a 4.5 kw. D.C. generator. Also many examples of turbines and accesories.

Intrcommunication telephones are imposingly shown by various firms specialising in this business. On Stand 64, Row C, the Telephone Mnfg. Co., Ltd. have their display. The exhibit of greatest novelty and utility is probably the new system "Secret Service Auto-line Finder and Indicating Intercommunicating Telephone." A general outline of its functions may be gathered from a consideration of what happens if we suppose that No. 5 station requires No. 9. No. 5 takes his telephone off the rest, turns the manual selector to No. 9 and presses the button. If the line is "disengaged" or otherwise, he gets an automatic indication. No. 9's "buzzer" sounds and he removes his telephone. This action sets his automatic selector-motor in motion. The little dial pointer ticks round until it reaches No. 5 and then comes to rest, simultaneously engaging with the "live" contact of the calling line (inside the telephone), and visually indicating on the dial the identity of the calling party. During the war the "Laryngaphone" was developed for the purpose of communication between pilot and observer in aircraft operations, it being unaffected by extraneous noises. The transmitter is strapped over the larnyx of the throat and reproduces all the sounds there originated. The development of the "Laryngaphone" opens up a range of useful applications, and the Telephone Manufacturing Co. are busy commercialising its many adaptations for ship and store use.

At Stand 66, Row C, the Relay Automatic Telephone Co., Ltd., are exhibiting a complete installation for an inter-departmental automatic telephone system giving facilities for connection to 50 telephones. It comprises the automatic switchboard, power board, two sets of 24-volt batteries, and telephone instruments, all connected up for use. (This system has recently been described in our columns.) An important feature is that two wires only are necessary between each individual telephone and the switchboard, and that the caller can connect himself to any of the other telephones served by the switchboard.

The Brit. L. M. Ericcson Mfg. Co., Ltd., show telephone instruments and switchboards, automatic screw work, small press work and magnetos of their manufacture on Stand 86a, Row E.

(To be concluded.)



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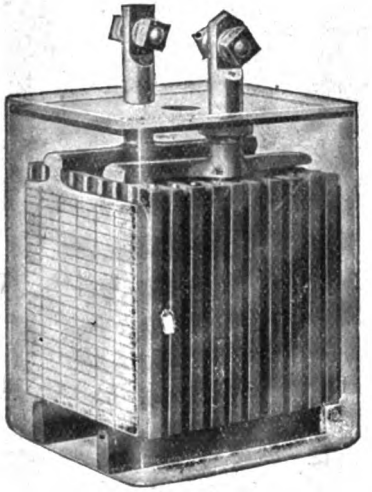
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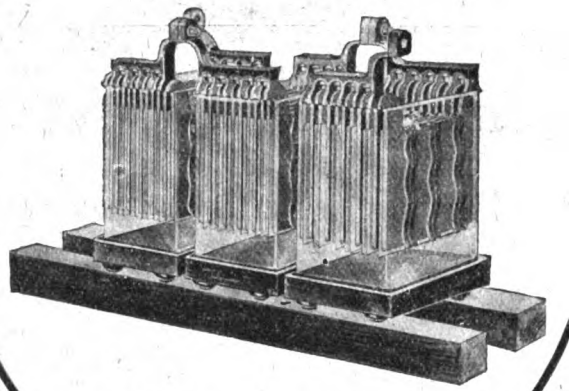
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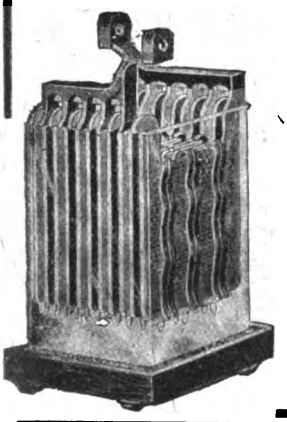
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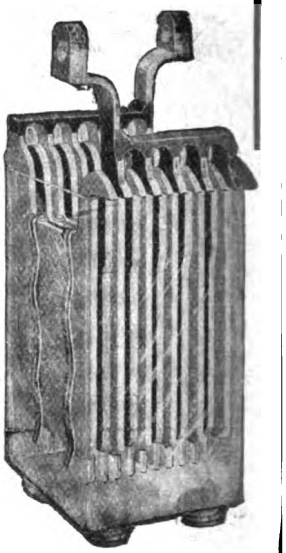
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ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 8s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2400 Gerrard.

Current Topics.

A Common-Sense Ruling From Chicago.

A recent ruling by the referee in the Chicago building trades dispute is calculated to send British trades union leaders to the nearest lunatic asylum. Yet it is pre-eminently sound and founded on ordinary horse sense. The referee in question returned a series of awards under which the wages of all classes of workers are reduced ten to thirty per cent. according to grade. In addition, many restrictions imposed by labour unions are condemned as leading to waste and inefficiency. The principal of these is the limitation hitherto imposed by the unions on the use of labour-saving machinery. In addition, the referee decided that when a sufficient number of union men cannot be obtained by builders, non-union men may be employed. Also that all restrictions on the daily output of individual workers must be removed. Unions must also allow small jobs, occupying not more than half an hour, to be performed by a man of another trade when insistence on the principle of a man performing nothing but the strict work of his own trade may cause an unnecessary waste of money.

Think it over, trades union readers, and you will have to admit that all the above rulings are founded on common-sense. For example, the question of labour-saving machinery; it is a long exploded fallacy that the adoption of such machinery reduces the demand for manual labour. On the contrary, it increases the demand by increasing the output in that particular section where the machines are used, thus yielding more employment in other sections. What logic can substantiate the action of the shipyard workers who still insist on twenty-three able-bodied men sitting and looking on whilst two of their number work an oxy-acetylene flame to cut a defective plate out of a ship's hull? Just because the original out-of-date method of removing the same plate by rivet-cutting needed twenty-five men, there is no justification for the retention of that number under the new and quicker process. Yet this is one of the silly hairs which Labour extremists are attempting to split at the present time.

Then that removal of restrictions as to individual output; why should not the best men be allowed to do their utmost to increase the productivity of industry? The labourer is worthy of his hire, and if one man is able to lay more bricks than his neighbour, run a greater length of conduit, fix more fittings, or make more joints in a given length of cable, why should he be denied the privilege of earning according to his toil? I also like that clause anent the half-hour's job outside his trade which the union man is to be allowed to perform. This would remove the restriction against a wireman having to wait for a paper-hanger to strip a wall before he could run wood casing, and would also enable a ship wireman to drill his own holes in the vessel's bulkheads where necessary, instead of having to call in an army of mechanics to do elementary tasks at great expense. Just ponder over the prosperity in trade which would inevitably follow on the exercise of a little sound common-sense and judgment by those who profess to lead trades unionism in this country.

More Light.

It is scarcely surprising that the Bradford Railwaymen's Union have approached the Corporation in the matter of better lighting of the streets of the city after dark, mainly for the benefit of those whose duties necessitate their being abroad when most of us are enjoying a well-earned night's rest. During the war we all grew accustomed to enforced darkness, and, after the early raid experiences, we were quite content to grope our way about as best we could with the aid of pocket torches, or even without them, when necessity compelled. With the demise of Dora, however, and the actual end of the war, one would have thought that the various municipal authorities responsible for public safety after dark would take the earliest opportunity to restore our pre-war illumination, especially as we have to pay the corresponding rate, whether we like it or not.

Instead, Bradford, and many other Corporations, apparently stricken with a mania for economy in the wrong direction, are deliberately restricting the lighting of their populous thoroughfares after dark, to the detriment and danger of residents and others. Bradford is by no means the only, nor the worst, offender in this connection, and, if public remonstrance and common-sense fail to achieve reform, we shall have to resort to the time-honoured privilege of withholding payment of the lighting rate as a protest against the barefaced robbery of the ratepayer. One can quite understand the need for husbanding local resources in these days of squandermania, and there are quite a number of moonlight nights when councillors can secure all the anti-waste votes they desire by not lighting the street lamps, but, if they carry their mistaken economy too far, they will find the inevitable answer at the November elections.

Object to Wooden Poles.

Hexham Council has achieved an unenviable notoriety by its recent action in respect of projected overhead electricity supply wires which the local Electric Lighting Company proposed to install on wooden poles throughout the area. The Town Clerk announced that, following a recent meeting at which the wooden poles were vetoed by the Council, he wrote to the Electricity Commissioners suggesting an inquiry. He had now received a letter from the Ministry of Transport stating that the projected work had been sanctioned, and that the inquiry

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was therefore refused as unnecessary in the circumstances. The Council forthwith decided to adhere to their original resolution that only steel poles be permitted, one councillor going so far as to suggest that they apply for an injunction if wooden poles were persisted in.

The report does not state whether the Council propose to finance the very largely increased cost of carrying out the scheme with steel poles, nor whether they will subsidise the electric lighting concern so that local consumers do not have to pay any more for their electrical energy. They have probably quite overlooked that side of the question, but would be the first to kick up a rumpus if called upon to pay 8d. instead of 4d. per unit for the lighting of the Town Hall. What's the matter with wooden poles, anyway? They can be made to look quite as sightly, if not more so, than steel columns, and are far cheaper in prime cost. It is conceivable that the vexed question of steel v. wooden posts for Hexham may decide the whole question of electricity supply for the districts now under consideration.

I commend to the consideration of Hexham Councillors a little village on the Pacific coast, where, as reported by a traveller in South America, few of the populace wear shoes, and the majority of dwellings are of mud and palm thatch. Yet an electric bulb swings in every hut, and the bare-footed laundress uses an electric iron. The local sawmill, also, is driven by electric power. A cascade on the village stream supplies the necessary energy, and boasts a surplus sufficient to fill the requirements of a town quite as big as Hexham.

Taxation and Trade.

As further evidence of the very serious way in which the present heavy taxation is strangling industry I notice that on the 16th inst. the Electrical Wholesalers' Federation, Ltd., sent the following telegram to the Chancellor of the Exchequer:—"At a meeting of the Electrical Wholesalers' Federation to-day the following resolution was passed: 'That the Federation of Electrical Wholesalers consider that taxation exceeds the limits that commerce can bear and that much more drastic economy than hitherto practiced is essential for the welfare of the country.'" This represents the feelings of a large group of wholesale firms who have big and varied business interests in this country, but although taxation is one, it is not the only factor operating to ruin trade. Of as great, or greater, importance are the demands made by Labour, and in large measure these demands are further reflected in increased taxation. I am glad, however, that Labour is now on the whole adopting a more reasonable attitude, and, although progress is slow, there is some justification for thinking that more normal conditions will soon prevail. ELEKTRON.

Faraday House Old Students' Dinner.—It has been decided by the Committee to hold the Annual Dinner at the Holborn Restaurant, Crown Room, on Friday, October 21st, at 6.30 (for 7). Mr. C. C. Paterson, O.B.E., M.Inst.C.E., M.I.E.E., F.Inst.P., the President will be in the Chair. It may be remembered that this was to have taken place on the 15th of April last, but had to be postponed at the last minute owing to the threatened transport strike.

FAULTS ON INSTRUMENTS.

By H. S. B. ROBINSON.

No doubt the reader is fully acquainted with those faults in connection with electrical measuring instruments which are of frequent occurrence, but there is one source of error, perhaps, not so well known and is usually associated with indicators, where a pointer moves on a dial. As this fault is liable to baffle even the most experienced of switchboard attendants, it is thought that a brief discussion may not only be of interest, but the means of avoiding defective readings.

It is evident that when instruments are used in a horizontal position there is always a certain amount of dust accumulates on the glass cover, which must be dispersed from time to time, with the result that the pointer of this type of instrument assumes false positions. This is brought about by the fact that to electrify the glass covering the dial of the instrument by friction, and consequently affecting the position or movement of the pointer, is not a difficult matter owing to the static charges developed thereon.

It will be seen that although the error introduced depends largely upon the atmospheric conditions, the quality of the glass itself, the material with which it has been cleaned, and also the method applied, it is also obvious that the length of the pointer, its distance from the glass covering, and the amount of force applied must also be taken into consideration.

Although an accidental rub with the coat sleeve or dry hand may easily introduce a defective reading, the pointer will gradually assume its correct position after the rubbing of the glass has ceased, but as this naturally takes time, the usefulness of the instrument is obviously destroyed.

It need hardly be mentioned that the more delicate the construction of the instrument, the greater the danger of obtaining an incorrect reading.

CARRIER CURRENT TELEPHONY AND TELEGRAPHY.

(*Concluded from page* 518.)

In a subsequent paper on the same subject read before the Franklin Institute, Chas. A. Culver, Ph.D., of Toronto, points out the limitations of the high-frequency multiplex system of telephony, and, incidentally, certain advantages. In dealing more specifically with the advantages, it is to be noted that, in general, guided-wave transmission gives a more nearly perfect reproduction of the voice than does wire telephony.

In ordinary telephony there are three inherent causes of distortion, viz., the microphone, the telephone receiver and that due to the line. The first two are, of course, present in the high-frequency system. The distortion due to the line is, however, absent. This is evident from the following considerations:—

Since the quality of timbre of vocal sounds is due to the presence of over-tones, the varying line current in ordinary wire transmission will also have a corresponding complex wave form. In short, when analysed, this telephonic line current consists of several elemental constituent parts, each component having a different frequency. Since, under a non-resonant condition, attenuation is a function of the frequency, the components of the line current corresponding to the over-tones in the voice will suffer different degrees of attenuation, with the result that the wave form will be modified. In ordinary words, tonal quality is not faithfully transmitted.

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If, in comparison with the process just outlined, it is recalled that in guided-wave transmission a high-frequency alternating current of a single frequency serves as a carrier wave, and that speech is transmitted by varying the *amplitude* of this carrier wave, it will be apparent that there will be no distortion due to a multiple valued attenuation factor.

There is a possibility that guided-wave telephone equipment of such a nature will be designed that the ordinary microphone, with its inherent defects, will be replaced by a device which will give rise to much less distortion. It is also possible to improve the common telephone receiver in regard to faithfulness of reproduction.

If, and when, these improvements are brought about, we will have in guided-wave telephony a means of communication whereby practically perfect transmission of the voice may be had. But even under existing limitations, the faithfulness of voice production in guided-wave transmission, particularly when connection is not made to local land lines, is one of the distinguishing characteristics of this method of communication.

Another important aspect of communication is secrecy. When used as a direct private line of telephonic communication, as in the case of leased lines between business houses in different cities or for press work, we have in this method a system of communication which affords a high degree of secrecy. Common experience indicates how little real privacy obtains when employing the ordinary telephone.

While radio-telephony has a distinct and very important field in communication at sea, it obviously has serious limitations when employed for strictly personal and business purposes. While there is no means of communication which cannot be "tapped," yet from the nature of the system, direct guided-wave telephony possesses the greatest element of secrecy of any telephonic means of communication. When, however, the high-frequency super-channel is used as a trunk line and connected at either or both ends with local physical telephone circuits, the element of secrecy is no greater than when employing a physical circuit for the entire distance.

Another advantage of the guided-wave system is that communication may be maintained between two points when the physical circuit which serves as a guide for the high-frequency waves is out of commission for ordinary telephone service. Both wires of the physical pair may be cut, the line short-circuited and at least one of the wires grounded without interrupting communication over the super-channel. This has been repeatedly demonstrated, and naturally means much in emergency service of all kinds.

Another feature to be noted in connection with guided-wave telephony is the flexibility of the system. When used as a through trunk channel, a given set of equipment may, as previously indicated, be instantly shifted from one physical circuit to another.

Further, the entire terminal guided-wave equipment may be quickly transported from one point on a physical system to another, thus making it possible to readily increase the traffic-carrying capacity of the lines between points where a temporary congestion exists, due to seasonal or other causes.

An added element of flexibility arises from the fact that various sections of physical circuits may be tied together to establish a through super-channel for trunk operation. For instance, several physical circuits may radiate from an intermediate point. Two physical circuits centring at this point may, by suitable means, be connected for the purpose of setting up a through guided-wave channel, and at the same time the two physical lines may be connected to any of the other lines centring at the point in question. In other words, the tying together of the lines for guided-wave working in no way limits the flexibility of the physical lines for regular telephonic operation.

An important possible application of telephony by guided waves is that of train dispatching. Reference has already been made to the fact that energy is radiated from a physical line which serves as a guide for high-frequency carrier currents. Though the amount of energy thus radiated is not great, it has been shown by practical tests that it is sufficient to make possible the establishment of telephonic communication between a moving train and the fixed stations connected to one of the physical circuits paralleling the track.

This is accomplished by installing on the train a radio-telephone equipment connected to a suitable antenna system placed at the top of a car or cars. When the two systems are properly adjusted there will be a mutual interchange of energy between the train's antenna and the physical telegraph or telephone circuit which is conveying the high-frequency carrier current from a fixed station.

The train equipment may be located in the baggage car with leads extending to the engine cab. The engineer could be equipped with a standard anti-noise transmitter and a receiver helmet similar to that used for radio-telephony on aeroplanes. So equipped, the engineer of a train could be in continuous and reliable communication with the train dispatcher. The utility of such a system in train dispatching is obvious.

Another possible application of a similar nature to the above would be the dispatching of electric railway traffic by this type of telephony. Small low-power guided-wave sets could be installed on inter-urban cars, and the trolley wire utilised for the purpose of guiding the carrier waves to and from central fixed points. The power supply used for operating the cars is usually of such a nature that it could also be directly utilised for operating the telephone apparatus. The conductor would thus be enabled to speak directly from the car to the operating official at the central office. The necessity for installing and maintaining an independent telephone circuit for dispatching purposes would thus be obviated.

Thus, there are several important special fields for the practical application of this comparatively new means of communication.

It is, however, as private leased lines and for long trunk circuits that guided-wave telephony will probably find its greatest field of usefulness. Ordinary local subscribers' telephones may be connected through the usual central switchboard to the high frequency apparatus, the switching being accomplished in substantially the same manner as when connecting to any physical toll circuit. In this manner, the guided-wave system is being commercially used to give additional channels for the handling of "long-haul" traffic,

Although independent guided-wave terminal equipment must be installed for each super-channel that is established, yet the initial and maintenance cost of additional physical circuits is substantially greater than the corresponding cost for the high frequency installation. In general, the financial saving increases as the length of the line increases. With regard to telegraphy, multiplex by means of guided-waves is already a commercial fact.

In conclusion, it may be said that we have in guided-wave multiplex telephony and telegraphy a distinct branch of communication engineering—a new art—which is to command the ability of the most able minds in both pure and applied science. And who shall say whither it will lead?

National Association of Supervising Electricians.—The President, Major T. Vincent Smith, M.C., in his address on the 13th inst., dealt in a very interesting and instructive way with the development of wireless in the war. He recounted several personal experiences at home and in the field.

Experiments with Coal and Oil.—With reference to the note in ELECTRICITY of August 26, p. 475, dealing with certain experiments at Leeds, these experiments were made at the generating station of the Tramways Dept., Crown Point, and not at the Corporation's principal power station in Whitehall Road.

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SOME ELLISON SWITCHGEAR SPECIALITIES.

(*Concluded from page* 511.)

"Unit" type switchgear is made for all industrial applications and intended to cover the field between the ordinary switch and fuse distribution board and the elaborate cellular switchboards for large power stations. The standard oil-break circuit breakers and starters lend themselves to the building up of quite complicated arrangements, yet each part is of simple robust construction. The units are supported by cast-iron stands, and are bolted together to form a compact totally-enclosed, weather and mistake-proof switchboard which safely withstand the roughest use. The breakers are bolted to a steel-plate chamber which contains the isolating switches and bus-bars, and carries the necessary instruments. Interlocking devices are provided between the isolating switches and the breakers. The illustration shows a seven-unit switchboard which was installed in a mill to control a group of five slip-ring motors, each driving a section of the mill. An oil-cooled rotor starter is included in each unit, mechanically interlocked with its circuit breaker. All the units are electrically interlocked to ensure that the various sections are started in correct sequence, and if one section is stopped, the others dependent on it are automatically shut down. Many of these switchboards have been installed in mines, where they have been subjected to very hard wear and tear, and have withstood falls of roof, without causing interruption of the supply. A typical board is shown in Fig. 3.

The crane control switch panel, shown in Fig. 4, is one of the panels forming part of the Ellison patented system of complete electric crane control equipment for D.C. and A.C. motors, which also includes controllers, resistances, limit switches and brake solenoids. All live parts are enclosed, and the panels comply in all respects with the requirements of the Home Office and Factory Acts. The gear on each panel includes a main air-break circuit breaker, with overload and no-volt releases, of ample size and breaking capacity to interrupt the supply with safety and certainty under the worst conditions of service, and to isolate the whole of the electrical gear on the crane when the supply fails; an overload inverse time element relay in the circuit of each motor, to trip the main breaker when a motor is overloaded or fails; pilot lamp with plug, socket and switch, and indicating instruments if required.

This method of employing one circuit breaker only reduces the number of elements to the minimum and increases the ease of manipulation. It is convenient for a quick re-start after a temporary stoppage, and there are no troublesome fuses to "blow" and be re-wired.

Drum type controllers are made for A.C. and D.C. motors for cranes, or for any purpose requiring frequent operation, where an ordinary starter intended for operation at long intervals cannot meet the conditions of service. Experience and experiment over a number of years has resulted in designs which have proved their suitability for onerous conditions. The barrels have contact segments which are readily accessible and replaceable when worn. The fingers are of patented design, adjustable for wear and with renewable tips. The arc shields are effective and magnetic blow-outs are fitted to the D.C. pattern. The contact fingers are disposed radially to the barrel and have roller tips, which are pressed on to the barrel contacts by springs. This design is a departure from existing types and has several advantages; the roller is mounted so that it can rotate, oscillate and lift, and consequently beds perfectly on the segment. The barrel contacts are shaped to prevent the possibility of an arc being blown inwards and spreading from finger to finger; a trouble which is sometimes present with a magnetic blow-out field parallel to the barrel. The handle lever is very strong and fitted with a device shaped to set itself correctly, so that no matter how the handle is left, it always comes to the right position to arrest motion, and cannot be moved from "forward" to "reverse" accidentally. Controllers are made in practically every type for series, shunt and compound D.C. motors and for squirrel-cage and slip-ring A.C. motors.

ELECTRICITY IN COAL MINES.

A conference was recently held between the Switchgear Section of the B.E.A.M.A. and Mr. J. A. B. Horsley, H.M. Electrical Inspector of Mines, in regard to the rules governing the construction and use of switchboards in mines, Dr. C. C. Garrard, Chairman of the Switchgear Technical Committee, being in the chair. As some of the matters for discussion also had their counterpart in factory switchboards, H.M. Electrical Inspector of factories, Mr. G. Scott Ram, was also invited to attend.

Mr. Ram having explained the bearing of the Factory Regulations on the points in question, Mr. Horsley dealt with the requirements of the Mines Rules and called attention to the information contained in "Mines and Quarries Form No. 11 (April 1921)," which contains the Electricity Regulations and the revised Official Memorandum thereon.

After full discussion, it was agreed to place on record the following views:—

(i) *The isolation of circuit breakers for cleaning or repairs:* In colliery surface switchboards when a switch-

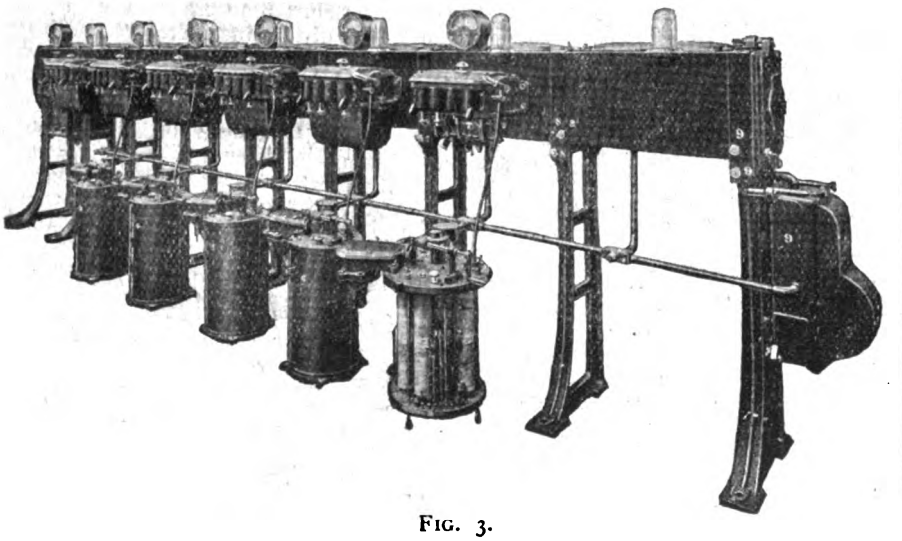


FIG. 3.

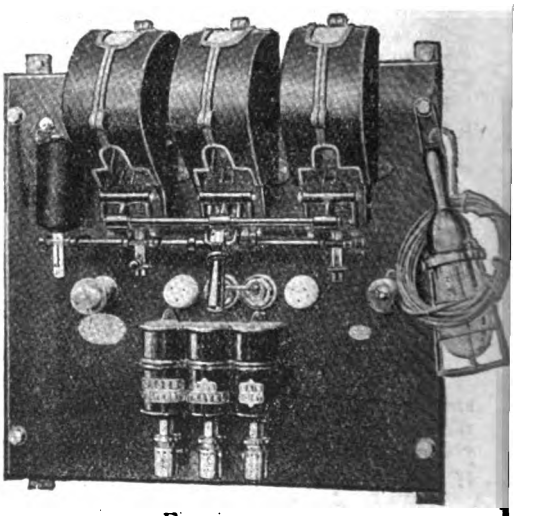


FIG. 4.

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board circuit comprising air break circuit breakers or contactors cannot be shut down regularly, say once a week exclusive of Sundays, to permit of cleaning and adjustment being carried out with safety, means must be provided for isolating such circuit breakers or contactors.

(ii) *Screening:* In view of the foregoing rule provision for fixed or movable partitions may or may not be necessary depending upon the nature and design of the switchboard.

(iii) *Insulating Barriers:* When a switchboard has open type busbars arranged in the horizontal plane, insulating barriers must be fixed between them, projecting at least 2 in. above the upper surface of the busbars.

(iv) *Shrouded Circuit Contacts:* When a surface switchboard contains cut-outs having surface contacts fixed on the front, and the distance between opposite poles is less than 6 in., such contacts must either be shrouded or protected by fillets provided between the poles.

SIMPLEX "TRIPLE PURPOSE" SIGNS.

The signs manufactured by Simplex Conduits Ltd. combine forceful and remunerative advertising with well distributed illumination and distinctive decoraton, and in the past have enjoyed large and increasing use in shop windows, stores, hotels, cinemas, theatres, etc. To aid their sales in the lighting season just commencing a wide distribution of publicity matter is being made from the Co.'s head office at Garrison Lane, Birmingham, to electrical contractors, multiple and other shop-keepers and most others interested in electric signs to augment the Press announcements which are appearing in the electrical trade journals and in the trade papers circulating among actual shopkeepers. Contractors would be well advised to do all in their power to develop the electric sign business. It is capable of almost unlimited extension if carefully nursed.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 124.

How would you find the direction of phase rotation on 2- and 3-phase systems? Is it possible to determine the direction of rotation of induction motors before switching on the current?—"S. H. ADAMS."

QUESTION NO. 125.

How would you calculate the number of turns in the stator windings of an induction motor? It is presumed that a few of the factors are known, such as speed, voltage, frequency, etc.—"S. H. ADAMS."

(Replies to questions Nos. 124 and 125 must be received not later than September 24, 1921.)

Answers to Questions.

QUESTION NO. 122.

Please can any reader give me full details of checking the ratios of various transformer connections, preferably "Scott," "Zig-zag," etc.?—J.E.H.

REPLIES TO QUESTION NO. 122.

The first prize (10s.) has been awarded to "Astatic" for the following reply:—

A commercial transformer may be said to be ideally perfect inasmuch as there are no losses between the primary and secondary coils. That is input equals output. This being so it will be understood that the voltage ratio is equal to the turns ratio between the primary and secondary coils.

The connections of transformers are very simple when it is remembered that a three-phase transformer may be said to consist of one transformer with three separate primary coils and three separate secondary coils. These separate coils are connected up as desired to produce results according to requirements. In other words, three single-phase transformers may be connected up to transform three-phase alternating current, two single-phase transformers may be connected up to produce two-phase alternating current, and so on.

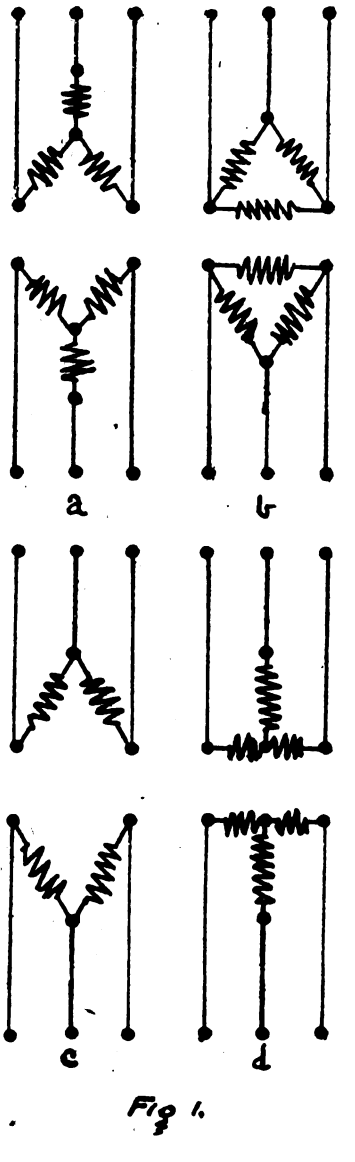


Fig 1.

With three single-phase transformers, or one three-phase transformer, a certain number of connections are possible. Some of these are illustrated in Fig. 1, *a*, *b*, *c*, and *d*.

(a) This is known as the star or Y connection. Here, if one phase fails, two phases are placed out of action; this means a complete shut-down of the transformer.

(b) This is known as the mesh or A connection. Here, if one phase winding should fail, the other would continue to supply a true three-phase current, but the system would be what is known as unbalanced. From this it will be seen that this system is to be preferred to the star.

(c) This is a comparatively new system, and is known as the V or open mesh connection. Here only two transformers are necessary. If this diagram is carefully considered it will be noticed that the phase difference between the two secondaries is the same as that between the primaries, thus a three-phase supply is maintained. The current in the third, or common, wire is the vector sum of the currents in the other two. The result is that the system is unbalanced. When this connection is used both transformers should be exactly the same.

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(d) This is termed a T connection. Here only two transformers are necessary. The voltages which are available at the terminals are not equal, that connected to the middle transformer being but $\frac{\sqrt{3}}{2}$ = 0.866 times the voltage between the line wires. A true three-phase supply is obtained at the terminals of the secondaries because the ratio of transformation is the same.

The Scott System.

This system is one by which the supply may be changed from three-phase to two-phase or *vice versâ*. In this system two transformers have their primaries T connected,

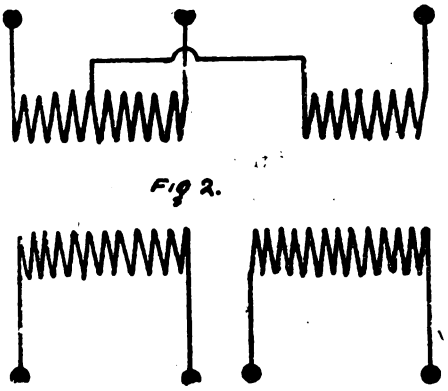


Fig 2.

as illustrated in Fig. 2, on to the three-phase supply. Their secondaries, however, are independently connected to deliver a true two-phase supply.

Referring to the term Zig-zag, I really do not know what "J. E. H." is referring to in connection with transformers. If, however, he will let me know, I will do my best to help him.—"ASTATIC."

The second prize (5s.) has been awarded to "M. M." for the following reply:—

Only a few details can be given, as a full account would mean a treatise.

In the "Scott" arrangement the secondaries of a two-phase transformer are wound so that one, which we will call *A*, has only approximately 86.7 per cent. the voltage of the other, which we will call *B*. The middle point of secondary of *B* is connected to one end of the secondary of *A*. There are then three *full* connections, two from *B* and one from *A*. These give a three-phase system. Thus transformation is obtainable from two-phase to three-phase. Also in reverse manner from three-phase to two-phase. Explanation is, that the voltages in the two-phase secondaries are at right angles to each other; therefore, when connected for three-phase half of *B* and whole of *A* are in series. Resultant voltages is therefore:

$$\sqrt{\left(\frac{100}{2}\right)^2 + (86.7)^2} = 100 \text{ (approx.)}$$

There are, then, equal voltages between the three leads.

The internected star winding—sometimes called "Zig-zag"—is employed to neutralise third harmonies in the secondaries. Each secondary winding is divided in half, and current from each line flows through the halves of two secondaries before reaching the neutral point. Triple harmonies are then neutralised, and the neutral point of system is approximately stable under various loads.

Ratio of transformation can be found from voltmeter readings. If intended for parallel working the transformers must have the same polarity; that is, the relative direction of flow of current in the several transformers must be similar. In alternating current sense is continually changing, but in any particular instant sense in each trasformer must be similar.

To determine polarity connect either the primary or the secondary winding to a three-phase supply. Join one phase of secondary with one phase of primary, and note voltage of the combination. This gives either the sum or the difference of the voltages, and therefore sense of flow. This is done with each phase and readings taken from the several terminals. From these readings similarity is determined, and therefore suitability for parallel working. —"M. M."

The ELLISON CATALOGUE of Electric Control Gear
gives full particulars, capacities, dimensions and prices of Ellison Control Gear. Please ask for List No. 60.
GEORGE ELLISON, PERRY BARR, BIRMINGHAM

ELEMENTARY DETERMINANTS
WITH SPECIAL REFERENCE TO KIRCHHOFF'S LAWS.

By H. P. FEW,
Silver Medallist in Telegraphy, etc.

THIRTEENTH ARTICLE.

NOTE.—The aim of these articles is to bring out prominently the advantages of employing determinants, in conjunction with Kirchhoff's laws, for finding current values in complicated networks of conductors. The previous articles appeared in our issues of June 25, August 6 and 27, September 17, October 22, December 3, 1920, February 25, March 25, May 6, June 24, July 29, and September 9, 1921, and gave an account, *inter alia*, of Kirchhoff's laws and corollaries, Maxwell's cyclic equations, general methods of evaluating determinants, application of determinants to finding current values in simple networks, including the Wheatstone Bridge, Thomson double bridge, bridge duplex and leak systems of telegraphy, etc. This article deals with an important problem in telephony.

In this article we apply the methods of determinants to the solution of a problem in telephony.

Telephone engineers will recognise in Fig. 28 the skeleton circuit of a so-called tie-line connection between two private branch exchange boards with an extension

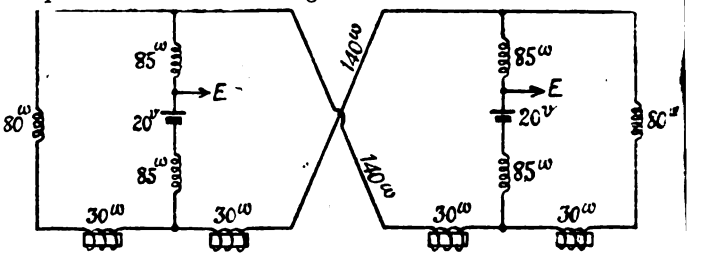


FIG. 28.

connection at each end. The resistances shown are typical of the actual values met in practice. Our object is to find the value of the current flowing through the extension instrument at each end, represented in the diagram by resistances of 80 ohms. The connections can be re-drawn more symmetrically, as shown in Fig. 29, assuming the resistances to be non-inductive.

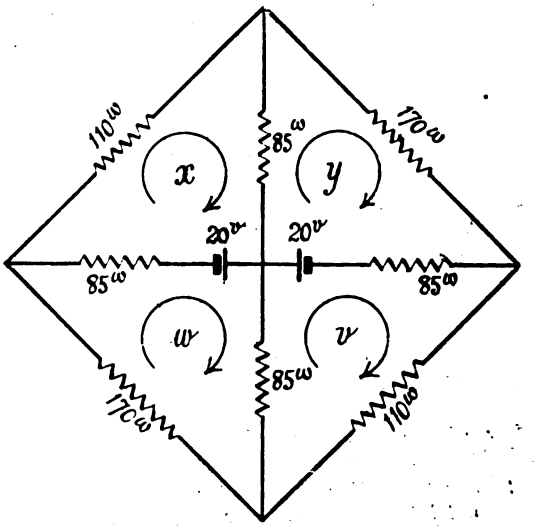


FIG. 29.

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Let cyclic currents x, y, w and v flow round the respective meshes as shown, then forming equations in accordance with Maxwell's rule—

$$\begin{aligned} 280x - 85y - 85w &= -20 \\ -85x + 340y - 85v &= 20 \\ -85x + 340w - 85v &= 20 \\ -85y - 85w + 280v &= -20 \end{aligned}$$

Forming the determinant for x, we have—

$$x = \begin{vmatrix} -20 & -85 & -85 & 0 \\ 20 & 340 & 0 & -85 \\ 20 & 0 & 340 & -85 \\ -20 & -85 & -85 & 280 \end{vmatrix} \Big/ \begin{vmatrix} 280 & -85 & -85 & 0 \\ -85 & 340 & 0 & -85 \\ -85 & 0 & 340 & -85 \\ 0 & -85 & -85 & 280 \end{vmatrix}$$

Taking first the numerator, add the first row to the second row to form a new second row; subtract the second row from the third row to form a new third row; then add the third row to the last row to form a new last row. The following determinant is then reached—

$$\begin{vmatrix} -20 & -85 & -85 & 0 \\ 0 & 255 & -85 & -85 \\ 0 & -340 & 340 & 0 \\ 0 & -85 & 255 & 195 \end{vmatrix}$$

which reduces to the following determinant of the third order—

$$-20 \begin{vmatrix} 255 & -85 & -85 \\ -340 & 340 & 0 \\ -85 & 255 & 195 \end{vmatrix}$$

which, expanded, gives—

$$-20[255\{(340 \times 195) - (255 \times 0)\} + 340\{(195 \times -85) - (255 \times -85)\} - 85\{(340 \times 85)\}]$$

which, multiplied out

$$= -323,680,000.$$

To evaluate the denominator, subtract the second row from the third row to form a new third row; subtract the last column from the first column to form a new first column; then add the first row to the last row to form a new last row. The following determinant is obtained—

$$\begin{vmatrix} 280 & -85 & -85 & 0 \\ 0 & 340 & 0 & -85 \\ 0 & -340 & 340 & 0 \\ 0 & -170 & -170 & 280 \end{vmatrix}$$

which reduces to—

$$280 \begin{vmatrix} 340 & 0 & -85 \\ -340 & 340 & 0 \\ -170 & -170 & 280 \end{vmatrix}$$

which, expanded, gives—

$$280\{340(340 \times 280) + 340(-170 \times -85) - 170(340 \times 85)\}$$

which, multiplied out

$$= 6,311,760,000$$

$$\therefore x = \frac{-323,680,000}{6,311,760,000}$$

$$= -51.28 \text{ milliamperes,}$$

the minus sign indicating that the current flows through the extension transmitter in the opposite direction to that shown in the diagram.

This result may easily be verified, for since the arrangement of conductors is symmetrical we can put $v = x$ and $w = y$, and the equations are then—

$$\begin{aligned} 280x - 170y &= -20 \\ -170x + 340y &= 20 \end{aligned}$$

whence

$$x = \begin{vmatrix} -20 & -170 \\ 20 & 340 \end{vmatrix} \Big/ \begin{vmatrix} 280 & -170 \\ -170 & 340 \end{vmatrix}$$

$$= \frac{(-20 \times 340) - (20 \times -170)}{(280 \times 340) - (170 \times 170)} = -51.28 \text{ milliamperes}$$

as before.

Similarly

$$y = \begin{vmatrix} 280 & -20 \\ -170 & 20 \end{vmatrix} \Big/ \begin{vmatrix} 280 & -170 \\ -170 & 340 \end{vmatrix} = 33.18 \text{ milliamperes,}$$

which is the value of the current through the tie-line.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.

THEORY OF WAVE TRANSMISSION. By Geo. Constantinesco. Vol. I. 212 pp. (Proprietors of Patents Controlling Wave Transmission, 132, Salisbury Square, E.C.4, 10s. 6d. net, 11s. 6d. post free.)—In 1914 the author of this book was experimenting on known scientific and mathematical lines concerning the design of apparatus operating on wave impulses transmitted through liquids. He was financed by Mr. Walter Haddon, Chairman of W. H. Dorman and Co., Ltd. (of Stafford), who are the sole licensees and manufacturers for Great Britain of Wave Portable Percussion and Rotary Tools, such as rock drills, riveters, etc., for mining and shipbuilding. The apparatus is simple and robust in construction and is quite fully treated in a catalogue issued by Dorman's but it can be understood without difficulty that the principle is a new one and no pre-existing literature covered the ground. Further, Professor Inglis, of Cambridge, has officially included the subject of Wave Transmission in the Mechanical Sciences Tripos of the University, and last session, for the first time, Wave Transmission was given as a subject for an examination paper.

It has already been demonstrated that practical apparatus can be made, but it is early yet to know exactly how it will behave over a number of years. It would appear, however, that it will be quite satisfactory, and developments will be made. During the war Wave Transmission was used to a very large extent for the automatic firing of guns on British and Allied aeroplanes. Under these conditions the volume under review possesses considerable fascination, but unless one has a highly developed mathematical mind, it is difficult of comprehension, and we doubt whether there are yet many men capable of dealing with it very critically, but it opens up a most promising field for research and study among young engineers. The author has coined the word "Sonics" for the science dealing with "all applications of elastic properties of liquids for the transmission of power." The new science differs from Hydraulics in so far as the latter deals with the application of properties of liquids considered as being practically incompressible, whereas "Sonics" relies entirely on the elastic properties of liquids for the transmission and utilisation of energy. The book deals with elementary physical principles, capacity, inertia, friction and leakage, currents in long pipes, the law of friction motors, sonic hammers, high-frequency currents, charged lines of transformers, etc. There are many tables and explanatory diagrams.

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MIND AND WORK. By Charles S. Myers. University of London Press. (Hodder and Stoughton. 6s. net.)—The psychology of labour is the real subject underlying this abstract of lectures and addresses delivered by the author at various times during the past two years. In spite of the deep-sounding title, it affords most absorbing reading from cover to cover, and introduces quite a new phase of the worker in modern industry. In short, it indicates how, by careful study and selection, as well as the putting into practice of certain well-defined principles, much greater output can be secured for the *same* or even *less* effort on the part of the individual worker.

The subject matter is divided under five main heads, viz., Movement Study; Fatigue Study: Selection Study; Incentive Study; and Industrial Unrest. There is also an important chapter (V.) on Systems of Payment.

Some extraordinary results have been obtained as the outcome of this new science. For example, in one factory it was found that 75 per cent. of the time was spent in handling tools, 15 per cent. in handling the machine under assembly, and only 10 per cent. on the actual job. Having made certain radical changes in the arrangement of tools, benches, etc., it was subsequently found, as a result, that, without increased fatigue but with increased piecework earnings, the men could assemble 66 machines a day as against a previous record of 18, a 266 per cent. increase in rate of output. Many other examples are given, but we will confine our extracts to one other, where a certain operation in another factory was reduced from 2.17 minutes, by motion study, to .5 minute.

This interesting study takes account of all contributory factors, such as the different ratios of fatigue set up by different tasks, the necessity for rest intervals where certain momentous movements have to be repeated a given number of times. It also goes into the question of selection of the correct temperament and training for a given job, so that square pegs need no longer remain in round holes. In short, if carried out in its entirety, the policy laid down by the new science promises a future Utopia for tired and disgruntled workers. It is a book which should be read and studied by all employers of labour.

Various Items.

Blackburn.—The Mill Hill dist. is now being provided with a supply of electricity from the new station. Messrs. Codling and Hodgkinson's Mill is being equipped with plant for both lighting and driving power, though this work will not be completed until Christmas.

Obituary.—The death, at the age of 57, is announced of Mr. Arthur A. Day, M.I.E.E., former Electrical Engineer of Bolton. He was elected to the position in Aug., 1900. In 1904 he took over the management of the Tramways. Under his control these departments made excellent progress, but in September, 1912, Mr. Day's health broke down, and he resigned both positions the following June.

Personal.—Messrs. Johnson & Phillips, Ltd., Charlton, have appointed Captain H. J. Groves-Webb, A.M.I.E.E., to be the Engineer and Branch Manager of their London Branch at 12, Union Court, Old Broad Street, E.C. 2, in succession to the late Mr. A. R. Connal. Captain Groves-Webb was appointed Chief Assistant Engineer at the London Branch in August, 1919, on his return from France, and enters upon his new duties immediately.

Bradford Technical College.—Courses of instruction in electrical, mechanical and civil engineering as well as in many other branches of industry are given. The electrical laboratories are well equipped for electrical machine work and general testing, while a small laboratory and dark room is set aside for photometric and allied purposes. Mr. W. H. N. James, A.R.C.Sc., A.M.I.E.E., is head of the E.E. Department. The Prospectus for 1921-22 is available, and the term commenced on the 20th inst.

Birmingham and Dist. Elec. Club.—The opening meeting of the winter session was held at the Grand Hotel, on Sat., the 10th inst. A paper was read by Mr. Norman Deykin (Member) on his recent experiences in Canada. The lecturer gave an interesting and enjoyable account of the many cities, towns, and natural scenery of the great Dominion, giving much information about Canadian electrical development and practice. His account of some of the great hydro-electric schemes, with their remarkable low charges for energy, filled those members of his audience who were industrial consumers of electrical energy with a desire to emigrate; whilst his account of the low prices for installation work, combined with the high cost of living, filled the contractors in the audience with an equal determination to stay at home; so that the balance of the industry in the Midlands is likely to be disturbed.

Trade Notes.

An illustrated price list from **Henry F. Purser & Brother,** manufacturing opticians (35, Charles St., Hatton Garden, E.C.1), gives particulars of "Purlux" kinematograph lenses as manufactured on their premises.

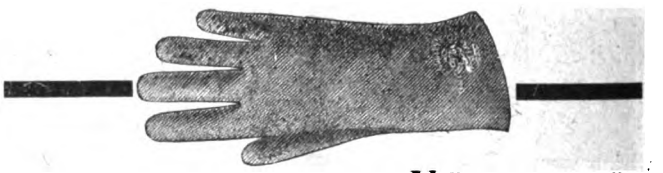
The firm of **George Ellison** (Perry Bar, Birmingham) has prepared a comprehensive list of lantern slides illustrating various types of electric control gear. The firm is willing to loan these slides to Engineering and Technical Societies and Technical Colleges. A full list may be obtained on application.

A 68 pp. Bulletin issued by **W. H. Dorman & Co., Ltd.** (Stafford), deals with Dorman Wave Power Tools. It contains an elementary explanation of the theory underlying their construction, illustrations and particulars of machines built and in operation for rock drilling, riveting, etc., for mining and shipbuilding. Plant can be seen at work at the Stafford Works.

Higgs Bros. (Sand Pits, Birmingham) have recently issued a convenient price list, covering A.C. and D.C. motors, motor-generators, dynamos and starting gear. It is intended purely for reference with regard to outputs and prices, as a special book containing the specifications is being issued. Higgs Bros. advise us that they stock 50 per cent. of the machines listed, while those not in stock can be delivered in 7-10 days, even if compound winding be necessary.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
SEPTEMBER 30, 1921.

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SOME INGENIOUS SWITCHGEAR AND OTHER ELECTRICAL ITEMS.

At the Engineering Exhibition at Olympia, just closed, an excellent display of some of their switchgear manufactures was made by the Igranic Electric Co., Ltd. (147, Queen Victoria Street, E.C.4). Included was an example of their patent unit type battery charging panel, built on the extensible bookcase principle, for charging and protecting the batteries of industrial electric vehicles, trucks and locomotives. We also noticed a "Pillar" type motor starting panel suitable for floor mounting, comprising a heavy duty type motor start interlocked with double-pole magnetically-operated circuit-breaker of the "Clapper" type, and a pole hand-operated isolating switch. This panel represents a new development in the method of enclosing the switchgear. The housing is split vertically, and the front portion is adapted to swing out from the frame, after simply loosening two wing nuts, thus giving easy access to the interior for inspection and cleaning. A patent automatic contactor type starting panel for starting a polyphase slip-ring induction motor was also shown. The contactor switches control both the stator and the rotor circuits. The rate of acceleration is determined by the load against which the motor starts. Various master devices are made. By one or other of these the panel can be operated, dependent upon whether the equipment is used in conjunction with a compressor, a pump, machine tool, etc. With particular interest we noted the "Auto-Reclose" circuit-breaker, a device which is almost uncanny in its behaviour. It will open on an overload or short circuit positively, but will not reclose nor try to close until the overload or short circuit has been removed from the lines it is protecting. On the other hand, when the circuit conditions warrant, it will positively close. In any case, an interval will take place between opening and reclosing, which period is adjustable and can be predetermined with accuracy. This latter is a valuable feature where several breakers are used, say, on the supply from a generator, as the intervals can be set so that the various circuits are brought on to the line in a definite sequence, preventing heavy surges on the line, and allowing the generators to pick up their load under the best conditions. Being magnetically closed, a no-voltage release is an inherent feature of all breakers. Therefore perfect and full protection is given to an installation under all conditions. Where hand-closed breakers are used and overloads are of frequent occurrence, the perhaps somewhat natural tendency of an attendant is either to set the trip far too high or block it so that the breaker becomes an expensive portion of the conductor and worse than useless. The human

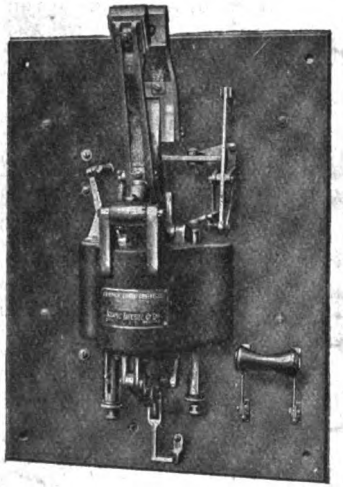


FIG. 1.

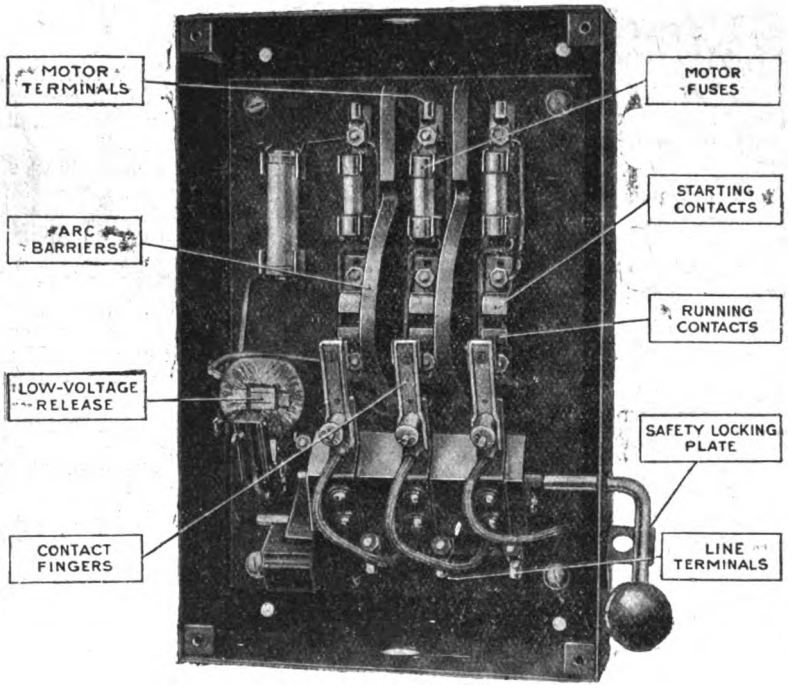


FIG. 2.

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element is entirely eliminated by the use of the "Auto-Reclose," and for this reason it can be described as a circuit controller. It is illustrated in Fig. 1.

Standard patterns include independent feeder breakers, tie feeder breakers and generator breakers. Various auxiliary safety and protective devices are also standardised, through which the closing coil of the breaker may be taken, the operation of any of which will cause the breaker to open. For instance, in an automatic or semi-automatic sub-station, hot bearings will open circuit by a thermostat relay, over-speed by a device driven from the shaft of a rotary converter, overload on A.C. side by interlock on A.C. breaker, A.C. voltage failure (enabling station to be shut down by disconnecting the A.C. power), reverse current by reverse current relay, or time switch arranged to open at a predetermined time. A time limit device can be also supplied for the overload trip. Such protection afforded by the auto-reclose circuit breaker is complete and is maintained without sacrificing continuity of service.

Another useful device of more extended application is the patent "Across the Line" type starter for squirrel cage motors, which can be directly connected across the line. The outstanding feature of these starters is the complete protection which they afford to both machine and operator. All live parts are enclosed. The fuses are out of circuit during starting, thus enabling the use of fuses of low enough capacity to protect the motor while running. When the front cover of the enclosing case is lowered for inspecting or for renewing the fuses, the switch is locked in the "off" position, and all exposed parts are dead. To start the motor the method of operation is as follows:—The operating lever at the right side of the case (Fig. 2) is raised and held up whilst the motor accelerates. During this time, while the motor is accelerating (and drawing a heavy current from the line), the fuses are out of circuit. When the motor is approximately up to speed, the operating handle may be allowed to drop to the running position. In this position the fuses are in circuit. In going from the "starting" to the "running" position the circuit to the motor is not broken. A low voltage protection device automatically opens the switch on a failure of voltage. The motor may be stopped by a slight downward pressure on the starting handle. Standard type fingers constitute the moving contacts. The stationary contacts are simple pieces of bar copper, bent to form, which an electrician could easily duplicate in an emergency. The operating handle may be locked in the "off" position to prevent unauthorised operation.

An electro-magnetic brake made of cast steel throughout has two pivotted armatures, and is so arranged that a central pull on both the brake blocks is obtained. Finally, among the other items note should be taken of the adjustable bi-polar drum armature winding machine. This machine is specially designed for winding small bi-polar armatures direct from the wire supply bobbin on to the armature core. Armatures arranged for either chord or diametrical winding, open or semi-enclosed, straight or twisted slots, can be wound with equal precision. The machine was in operation and demonstrations were given. As an example it might be recorded that a 16 slot, 3½ inch armature can be wound complete, with ends selected, 72 turns, two in parallel, in seven minutes.

ELECTRO-PLATING.

By C. SYLVESTER, A.M.I.E.E., A.M.I.Mech.E.

(*Continued from page* 344.)

Plating Baths.—Plating baths will vary in size and construction according to the articles to be plated. One often hears of lead lined baths. These are only used for certain purposes, but the lead is not actually a lining of the bath but an insertion, Fig. 9.

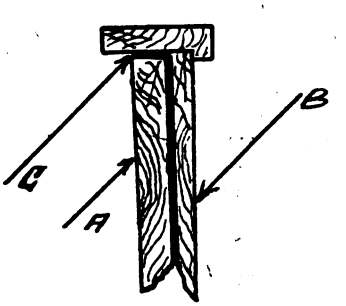


Fig 9

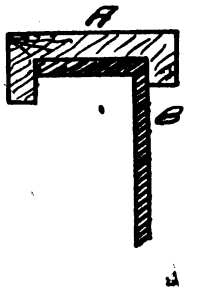


Fig 10

This diagram shows one side of a bath in part section. From this it will be seen that the complete bath really consists of two wooden baths placed one inside the other with a lead bath inserted between them. The inner wooden bath is made of thin match boarding, and the outer wooden bath is made of much more stronger material. The lead is chemically pure and is burnt at the joints. A is the outer bath, B the inner bath, and C is the lead bath. Such a bath is used for nickel, cold copper, silver and cold zinc solutions.

For some purposes, especially where large quantities of solution is being used, iron baths may be found to be much more cheaper, and quite as satisfactory and as strong as wooden baths. Where iron baths are used, however, they should be lined with cement or enamelled. If cement is used, then it should be carried out by an expert, who will understand the correct mixture of material to use which will allow for the variation of temperatures and, at the same time, be water-tight. In other words, the mixture of cement should be such that it will not crack under varying temperatures, since, if it does, the object for which it is lined is defeated. Regarding enamelled baths, it may be found to be very difficult to get these enamelled unless they can be purchased already enamelled. It is obvious that an enamelled bath is to be preferred to one that is cemented. They are, however, very easily chipped or cracked if care is not taken when inserting or removing the anodes and cathodes. It may be said that it is the usual practice to use iron baths for hot solutions, such as copper, brass, tin, etc. When an iron bath is used a wooden frame should be placed round the top, as illustrated in Fig. 10. In this sketch A is the wooden frame and B is the bath.

Cleaning Tanks.—A number of cleaning tanks, sometimes termed potash tanks, are necessary The number and size will, again, depend upon the amount of work to be done. These are usually made of a good quality of wrought-iron which is as free from slag as possible. These tanks are subjected to a constant heating, approximately 200 degree Fah., so if they are not made of good material they will buckle. To assist in the prevention of buckling, it is sometimes the practice to partly embed the tank in a brick foundation. This method is quite satisfactory and convenient if one is using tanks that are already on hand.

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If, however, the tanks are to be made to specification, it will be much better to specify that the sides of the tanks shall be strengthened with pieces of angle iron. Cleaning tanks are *not* galvanised.

Heating of Tanks.—The heating of the tanks must be taken into consideration when the lay-out of the plant is considered. Where steam is available, the heating of tanks can be carried out under excellent conditions, both with economy and cleanliness. If the plating shop is erected in a works, in close proximity to a steam range, then a supply of steam may be taken from the range to the tanks. The method of heating is to place a number of coils in the bottom of the tank, Fig 11. This illustration shows two

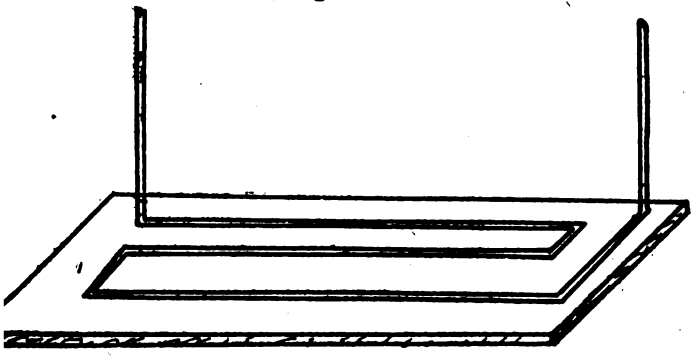


FIG. 11.

turns, or coils, on the bottom of a tank. From this it will be seen that the heating effect will depend upon the size of the tank and the number of turns or coils in the pipe. In other words, it will depend upon the area of the heating element.

If no main steam range is available, it will be found to be very economical to have a small vertical boiler fitted from which a supply of steam may be obtained for an indefinite period. By this it will be understood that the whole of the tanks and pans must be taken into consideration when selecting a boiler. The capacity of the boiler should be correctly ascertained and compared with the consumption of the pans and tanks. This is most essential because it should be remembered that the contents of the cleaning tank must be almost boiling point before plating can be commenced.

Hot-Water Tanks.—Several of these will be needed. The supply of hot water to these is not a difficult proposition if gas is fitted in the plating shop. A geyser will supply water to a main tank from which hot water may be drawn to the hot-water tanks as necessary. Hot-water tanks are made of wrought-iron, strengthened inside with angle iron, and the whole thoroughly galvanised.

Sawdust Pans.—The use of sawdust pans in a plating shop is most essential. Since the sawdust is continually being disturbed with wet material, it is essential that some method should be adopted to keep the sawdust dry. Therefore, sawdust pans generally have a false bottom which will enable the sawdust to be heated with either steam or gas. If steam heated, all that is necessary is a few coils of pipe. With gas, however, where the flame is played direct on to the bottom of the pan, the false bottom has to be filled with water to prevent the sawdust from burning.

Scouring Pans or Troughs.—A number of these will be required according, again, to the capacity of the plant. They are made of very stiff boards, bolted together outside, and lined with sheet lead inside. In supplying water to these troughs a certain amount of method should be adopted. That is, the supply pipe should be as central as possible, and its size should be reduced as it passes each trough. In this manner each trough will get its correct complement of water irrespective of the number of taps which may be on at once. A plug should be fitted in the bottom of the trough, and an overflow hole in the side near the top. Wooden boards, to build a complete platform, should be fitted with ledges underneath them so that they are quite rigid when placed on the top of the trough. A number of these boards should be used so that platforms of various widths may be built up. The platform is, of course, for the work to be scoured upon.

Dipping Pans.—These are made of highly vitreous earthenware or porcelain. Three or four will be quite ample for an average size plating plant. They are used to contain acids such as nitric acid, etc. They should be provided with a closely fitting cover to prevent the fumes from rising when they are not in use.

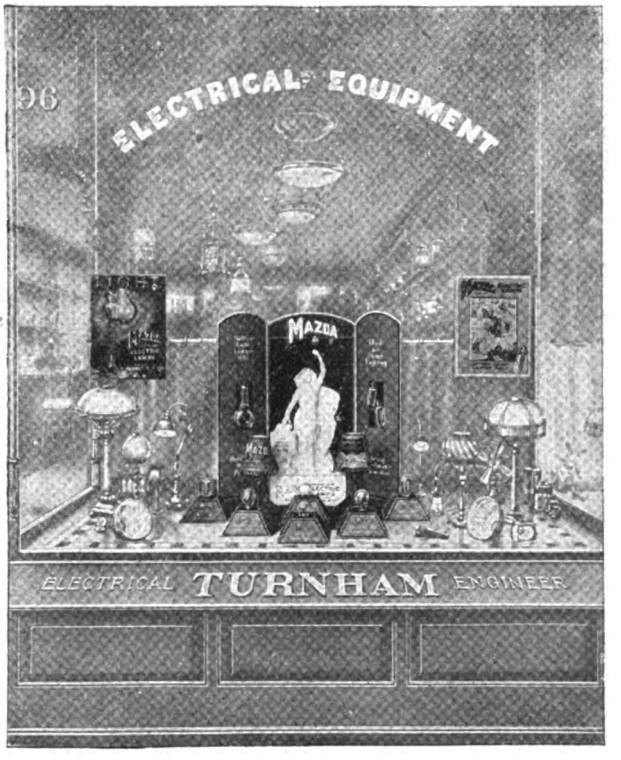
(To be continued.)

THE MAZDA WINDOW DISPLAY.

The B.T.-H. Co., Ltd., have produced a very fine Mazda Window Display, which has been designed not merely to advertise Mazda lamps effectively, but also to permit of its being rapidly and conveniently installed in any kind or size of window. It can be erected in a few minutes, and it is not necessary for the window to be cleared for its reception. The display consists of a number of separate articles, which may be arranged in different ways, thus giving scope for variety of treatment. The items comprised are one papier mâché model, two feet high; one three-sided cardboard screen printed in three colours; six pyramidal lamp stands; two Mazda revolving lamp shades; two mounted showcards, each printed in 12 colours. One showcard is reproduced from a humorous drawing by Heath Robinson, and the other is an impressive symbolic design by the famous artist, Septimus Scott.

The general colour scheme is harmonious—wedgewood blue and orange chrome predominating—the whole presenting an artistic and dignified appearance calculated to arrest the attention of passers-by.

A limited number of these displays are available for distribution to dealers who stock Mazda lamps. The displays are lent for a fortnight and must then be returned to the company. Further information on this matter may be obtained from the Advertising Dept. of the British Thomson-Houston Co., Ltd., 77, Upper Thames Street, E.C.4, or from the company's nearest branch office.



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THE ENGINEERING EXHIBITION.

(*Concluded from page* 526.)

Among the other exhibits of electrical interest in the Exhibition at Olympia, which closed on Wednesday, were the following:—Various electrical and engineering specialities, including electric drills, small motors, dynamos, lighting and starting equipments for motor vehicles, etc., by W. White, of 222, Barcombe Avenue, S.W.2, and a somewhat similar display by Dieny and Lucas, of 329, High Holborn, W.C.1. Speciments of various wires and cables were shown by the Concordia Electric Wire Co., Ltd., of Trent Mills, New Sawley, Derbyshire.

Much interest was taken in the stand occupied by Vikings-Tenax, Ltd. (10, Vigo Street, Regent Street, W.1), where, besides a selection of electrical material of Danish manufacture, beaten copper work, lathes and other machinery, samples were shown of files taken from the scrap heap, and resharpened by a process without detempering or obliterating the maker's name or other marks in any way. The process was not divulged, but it is not sand-blasting. We are inclined, however, to the belief that it is in some manner a chemical process, but whatever it is, if a file is worn down so as to become useless it can be re-sharpened so as to be in a condition to stand up to practically the same amount of work as a new file of the same make. Damaged files are resharpened for rough work only, as the elimination of blemishes would tend to make the file too light, and, of course, would cost more. We understand that a number of large file users, including railway, tramway and omnibus companies and other engineering concerns are customers of the V.-T. Co. Prices are quoted for resharpening in dozen lots and upwards.

A new aluminium solder, called "Alubon," was shown by the Melvin Engineering Co., Ltd. (5, Old Compton Street W.1). It requires no flux. To use, the parts to be repaired must be thoroughly cleaned and finished with a rough file, then heated and "tinned" with Alubon separately, using a coarse scratch brush to clean off excess solder. The parts to be joined are then set firmly in position, the joint heated, and more Alubon run over the "tinned" parts. It is most important that the job be not disturbed in any way until the solder has set. Blow-holes and cracks in castings can be repaired in a similar way.

Included in a display of electric lighting, heating and cooking appliances, the Thunbury Co. (91, St. George's Square, Westminster, S.W.1) showed the Wallace reading lamp. This is a unique device, which comes to pieces in a most ingenious manner and packs up most conveniently for travelling use. It can be used either standing on its base or hung on chair back, bed, dressing table, etc., by means of a spring clip concealed in the base. Another novelty was a cigar or pipe lighter of artistic design, so arranged that the glower only glows when the device is lifted off its place of rest. The company also showed "Aurora" colour changing and flashing signs. These are made in various forms of ground glass, behind which is an electric lamp with a tube of coloured mica suspended round it. Little vanes at the top cause the tube to be rotated by the ascending hot air currents from the lamp. By the provision of a thermal flasher the lamp may also be switched on and off, so adding to the effect. The principle is also applied to an electric radiator. The Wizza spark intensifier, also supplied by the Thunbury Co., for use in internal combustion engines, makes use of the fact that the introduction of a spark gap between magneto and plug increases the intensity of the spark across the plug points. The body of the device consists of a vulcanite tube into which two substantial brass points are introduced. A hole is drilled in the vulcanite casing, so that the spark gap is visible. A strip of brass secured to the base of the device is brought out at right angles and drilled to slip over the plug terminal, whilst another and longer strip, to which an insulated knob is secured, is carried down to form a plug tester. A glass tube surrounds the brass points, which are set about 1/64 in. apart.

The "Astral" electric light intensifier (M. L. Slaughter and Co., Ltd., of 91, Victoria Street, S.W.1) is a reflector of unbreakable material with a good reflecting surface. It is well designed so as to slip over the cap and rest on the glass bulb of a metal filament lamp to concentrate the light in the direction of the pip. The Faraday House Testing Laboratories issued the following report:—

"The *Astral Intensifier*, which was cone-shaped, 2 in. deep and 5½ in. diameter at the bottom, was placed on a 60-watt Ediswan Lamp, the top of the intensifier being approximately 2 in. below the lamp top. The *illumination* on a screen vertically below the lamp and placed at a distance of 3 feet from it was *measured and found to be* 24.0 *foot candles*. The *illumination* was also measured with the same lamp, but with the *Intensifier removed* and in the same vertical direction as before. The illumination was then *found to be only* 0.7 *foot candles*. The illumination given by the lamp in this direction *with the Astral Intensifier* is therefore 34½ *times greater than without it*."

The Hotpoint Electric Appliance Co., Ltd. (21 Berners Street, W.1), showed a comprehensive selection of "Hotpoint" heating and cooking apparatus, the "Premier" electric suction cleaner, the "Hotpoint-Walker" electric dish washer and the "Aerobell" clothes washer. This comprises two vacuum cups to which a rotational and up and down movement is given. They are housed in a cylindrical copper tub on three legs, the driving motor and gears being underneath and well housed. A multi-positional wringer, complete with control lever and safety release, is also conveniently affixed. The suction mechanism of the washer gently forces the soapy water through the clothes on each downward stroke and draws it up on the upward stroke. At the end of each upward stroke—when the vacuum cups are entirely clear of water and clothes—they revolve a fraction of a turn before coming down again. The clothes themselves are kept in constant motion turning over and over. Therefore all of them come under the gentle cleansing action of the cups. There is none of the wear and tear due to dragging or forcing the clothes over a hard surface. It is claimed that the "Aerobell" will cleanse the heaviest blankets and the daintiest fabrics with equal effectiveness and without the slightest injury.

Vacuum Cleaners and the "Laundry Queen" washer were also demonstrated by the Northern Steel and Hardware Co., Ltd. (9, South Parade, Deansgate, Manchester), and the well-known "Daisy" vacuum cleaners by the "Daisy" Vacuum Cleaner Co., Ltd. (Leamington Road, Gravelly Hill, Birmingham).

Theo and Co. (6 and 6a, Hatton Garden, E.C.1) showed their latest designs of "Electric-Automate" self-generating hand lamps. They comprise a complete dynamo electric generator and lamp in a small, conveniently-designed case. By means of step-up gearing and a rachet arrangement a hand lever or chain rotates a permanent field magnet, the current thereby generated in the stationary armature passing direct to the lamp. The sets are made up in different forms for carrying in the pocket, for policemen, postmen, cycle lighting, signalling (through red and green glass), inspection purposes, etc. The pocket lamp weighs only 12 oz. Sections of the lamp and component parts were also shown. We understand that the lamps are guaranteed for six months.

Caerphilly.—Mr. William Spickett, the clerk to the U.D. Council, has advised that body that it was impossible for the Council to take debentures in the South Wales Power Co., Ltd. One of the members urged the Council not to undertake the generation of current, as the price they would have to charge would be prohibitive. The question has been deferred.

Ediswan at Sea.—At the request of Captain Williams, biologist to the Shackleton-Rowett Expedition, a 100 C.P. "Pointolite" outfit has been provided for his use by The Edison Swan Electric Co., Ltd. The "Pointolite" Lamp was considered by Captain Williams to be the best possible source of light for critical examination and microscopic work.

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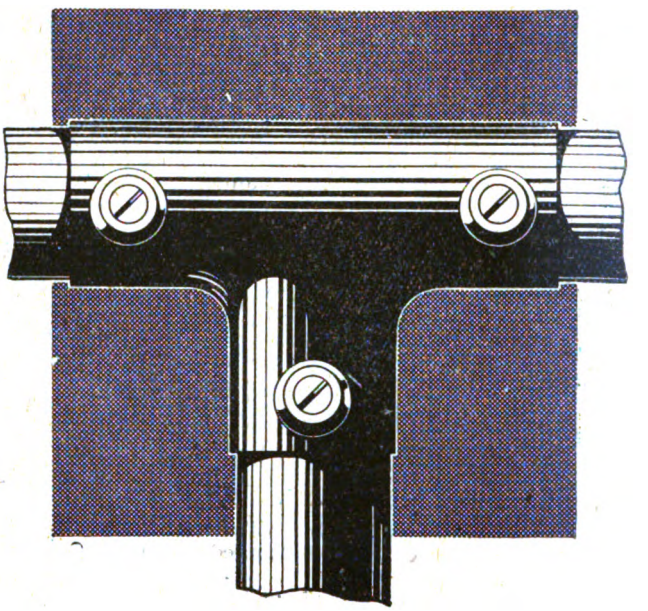




Fig. 1.

This system has been introduced to provide a cheaper means of effecting ample and permanent electrical conductivity in ordinary close joint conduit installations than is possible with the Simplex Hexagon Grip Continuity System ; in fact an installation erected on this system costs but little more than one on the plain socket joint system.

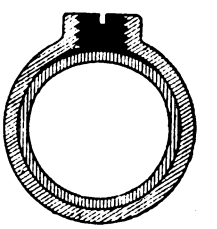


Fig. 2.

DESCRIPTION :

Each outlet of every fitting has a drilled screw and tapped boss for housing a steel screw of the formation shown in Fig. 1.

After the conduit is inserted into the outlet of the fitting the screw is driven home, and by virtue of its structure the cup-shaped projection of the screw on making contact with the conduit expands as shown in Fig. 2. In expanding the enamel is automatically scraped off the conduit, thus ensuring a degree of continuity which is obtained with no other system on the market except by actually scraping off the enamel before insertion.

Further, the expansion of the cup-shaped projection automatically locks the screw in position, thus making it impossible to loosen under vibration. This constitutes a very important advantage of the "Terra-Grip" Continuity System, and is a feature due solely to the peculiar formation of the "Terra-Grip" Screw and is to be found in no other system.

TESTS :

Conductivity tests on "Terra-Grip" junctions have been carried out by the Electrical Engineering Department of the University of Birmingham, by measuring the potential drop in millivolts across a number of conduit "Terra-Grip" junctions in series.

Currents up to 40 amperes were passed through the conduit and junctions and the average resistance per junction was found to be only

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thus proving the remarkably good conductivity of the "Terra-Grip" junctions.

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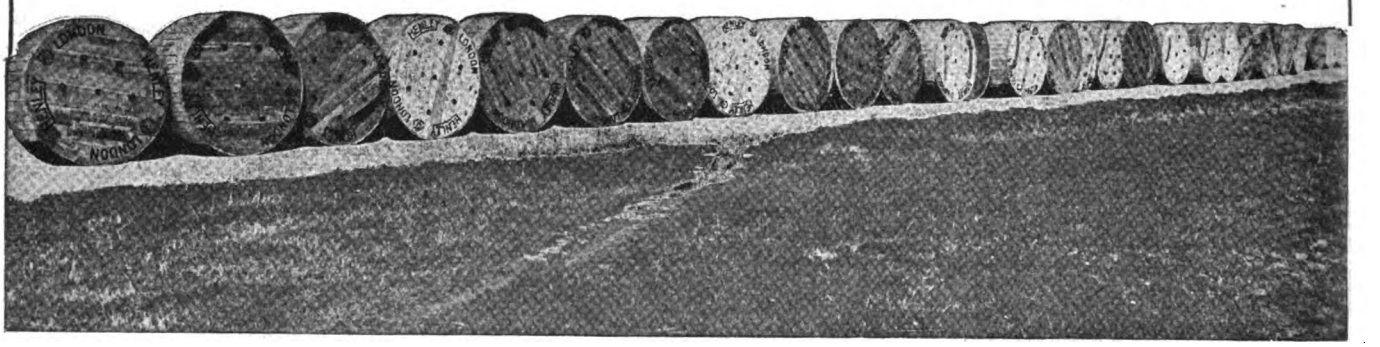
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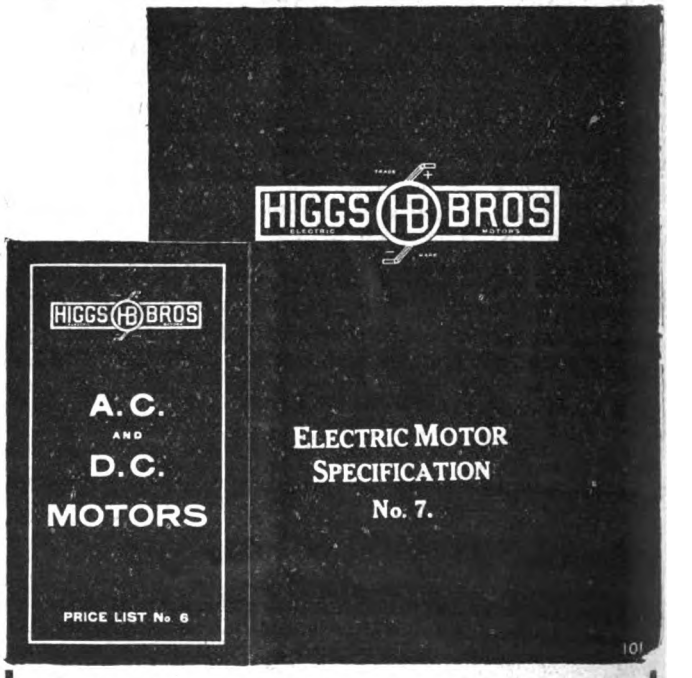
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 4d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 8s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 92-99, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Is England Changing?

That well-known writer, Mr. Harold Begbie, recently penned an article for the *Sunday Chronicle* on a Changing England, which I read with greater interest by virtue of the fact that I had just returned from a motor tour which took me right across this country of ours from west to east. I have not visited East Anglia, where I was born, for twenty years, and am, therefore, competent to draw comparisons based on memories of that part of England two decades ago. I used my powers of observation freely *en route,* and can say definitely that, once the Fen district is passed, East Anglia to me appeared just the same as when I was last in the district. Even the roads had the same misleading sign-posts, misdirecting the unwary traveller to some remote village he has no desire to visit, and, to all appearance, many of them had not enjoyed even a coat of paint since I last saw them.

The same windmill grinds the corn for which these counties are famous, and the arrival or departure of a train on the Mid-Suffolk Light Railway, put into commission some twenty years ago, is still an "event" at the curious little country stations one comes across in the most unlikely spots. In my birthplace oil-lamps are still the only means of illumination after dark, and up-to-date residents extol the merits of "central draught" lamps. The Court House—in my youth the Corn Hall or Corn Exchange—still stands, and is used for concerts, entertainments, etc., whilst the village is wholly dependent upon the town pond for its water-supply, every gallon of which has to be pumped by hand. Think of it, ye dwellers in modern business or industrial centres, and marvel upon the contrasts associated with this beautiful country which is our birthright.

As a tribute to the healthiness of these rural surroundings, I visited a few old friends of my youth, among them a brisk old dame of 104, who well remembers the Coronation of Victoria the Good, but is less definite regarding events immediately preceding the great war. According to the local medico, she has the heart of a woman of 60, yet exists without electric light, gas, modern water-supply, or any of the so-called benefits of the present age. Incidentally, the effects of the drought were plainly evident both in the Fens and in East Anglia. I passed miles of dykes which, normally flush, were mostly dry and covered with sun-burnt vegetation. At one small inn at which I begged water for my radiator I was informed that the pump had sucked dry weeks ago, and that they were dependent on cottage neighbours, in whose small pond there still remained a few gallons of the precious fluid. Evidently hydro-electric schemes are not destined to flourish in this part of the British Isles.

At Melton Mowbray, a pretty old market town, where the celebrated pies come from, I stayed at an old-fashioned hunting hotel, where they fed and accommodated me in good old English style. Here, wonder of wonders, was electric light, supplied through neat overhead conductors from a steel works a few miles distant. In keeping with the old-world character of the place, the hotel boasted a Gower-Bell telephone, one of the very early models common to the public telephone service of my youth. Other innovations marking a gradual change were a very excellent kinema, and the electrical illuminaion of the church and clock-tower. The building was decorated for harvest festival, and the effect of the lighted interior on a fine autumnal evening was very striking.

From Melton, through busy Loughborough, to still busier Derby, along the London Road, one passes, as it were, from the nineteenth to the twentieth century, and, passing through the streets of the latter town on Monday morning, the only blot on the landscape was the obvious preponderance of unemployed and the queue at the Labour Exchange. After all that they have gone through for the sake of England, it is sad to see so many of these well-set-up examples of the youth of our country seeking the wherewithal to live and enjoy existence. Let us hope that a way will soon be found out of the impasse created by the collapsed exchanges which are crippling our export trade, and that we shall soon once more respond to the call for British goods from overseas.

Million-volts Transmission.

America is the birthplace of big ideas, and it is therefore scarcely surprising to learn that electrical energy has been successfully transmitted at the abnormal potential of 1,000,000 volts at Pittsfield, Massachusetts, U.S.A. This record feat has been accomplished by the engineers of the General Electric Company of U.S.A., and may mark the beginning of a new era in electric-power transmission. According to the meagre reports so far available, the insulation and other physical difficulties have been successfully overcome, although a minimum limiting distance of fifteen feet is mentioned as necessary clearance around the "live" conductors, which were of tubular form, four inches in diameter. This is an interesting example of history repeating itself, as it will be recalled that the early Ferranti experiments in high-tension distribution were accomplished with the aid of tubular copper conductors, founded on the theory that electricity flows only along the surface of such conductors.

The generation and maintenance of such a high pressure, with "beef" behind it, is no mean accomplishment, having regard to the insulation problems involved in generator and transformer windings, and the fact that at such enormous pressures even dry air becomes some sort of conductor of electricity. If this early success is followed by a practical development of

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the principle of very high-voltage transmission we would appear to be approaching the point where "wire" and "wireless" principles become interlinked, for at potentials of the order of a million volts both Herzian waves and dynamo-electric forces must be closely allied. In this connection it is interesting to note that at a recent convention of the American Institute of Electrical Engineers Mr. Frank S. Baum, a consulting engineer of San Francisco, presented an exhaustive paper on the subject of high-voltage transmission, in which he recommended the adoption of 220,000 volts and 60 cycles for long lines, and discussed the regulation of lines up to 800 miles in length.

Looking into the future and drawing somewhat on the imagination, one can mentally depict the beautiful spectacle presented by a network of these high-tension transmission lines after dark. Even at present voltages as adopted in U.S.A., the eighty miles of transmission line which supply current from Niagara to Buffalo can be seen vividly glowing, owing to the corona effect or static discharge which is constantly going on along the route followed by the overhead conductors. In one report of the million-volt experiment it is stated that spectacular experiments were conducted within the Pittsfield power-house, the pressure of the current being computed from the length of the gap it was able to leap between two points in the circuit. As the voltage was "stepped up" by specially constructed transformers, the spark-gap gradually widened until, finally, a brilliant blue flame was leaping no less than fifteen feet through the air. Some spark!

ELEKTRON.

J.P. MINING CABLE BOXES.

Some standard cable boxes for use in coal mines are dealt with in a new revised list (No. J.B.1), issued by Johnson & Phillips, Ltd. (Charlton, S.E. 7). The Universal distribution box illustrated in Fig. 1 is designed for erecting on walls, roofs, or inbyes of the workings, and is suitable for twin cables up to 7/.064 S.W.A. or D.W.A., and can be arranged for distributing one, two, three or four ways. The construction being clearly shown, there is no need for further description. A bulkhead fitting can be used instead of the well-glass fitting if desired, or, of course, a cover can be substituted for the fitting.

The Gate End box shown in Fig. 2 (closed) and Fig. 3 (open) is so designed that the interior can be arranged for two or three poles, consisting of the J. & P. patent quick make and break knife switches, externally operated; also with fuses with standard porcelain handle, renewable type, or with cartridge fuses if preferred. The plug for trailing cables has armouring clamp and stuffing glands and can be filled with compound. Each plug is fitted with an earth pin, which makes contact before and breaks contact after the pole pins. The plug can only be introduced one way into the socket, thus insuring against accidents. A special feature is the interlocking gear. As every portion is inside the case it cannot be damaged. Further, the whole is controlled by the movement of the switch handle; the cover cannot be opened when the switch is in circuit or the switch operated when the cover is open. The same remarks also apply to the plug, for this cannot be removed while the switch is in circuit, or the switch operated when the plug is removed, and as the blades of the switch are dead when the circuit is open, absolute safety is insured.

Various disconnecting and dividing boxes are described in the list referred to above, while the Company intimates that it is always open to manufacture to special requirements.

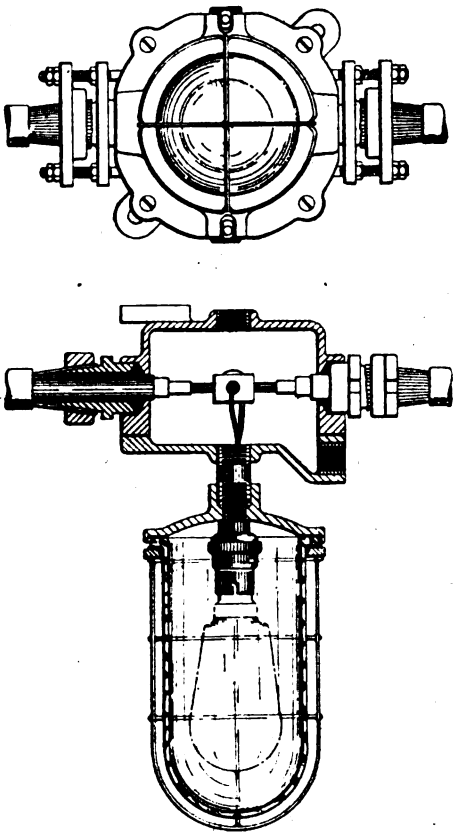


FIG. 1.

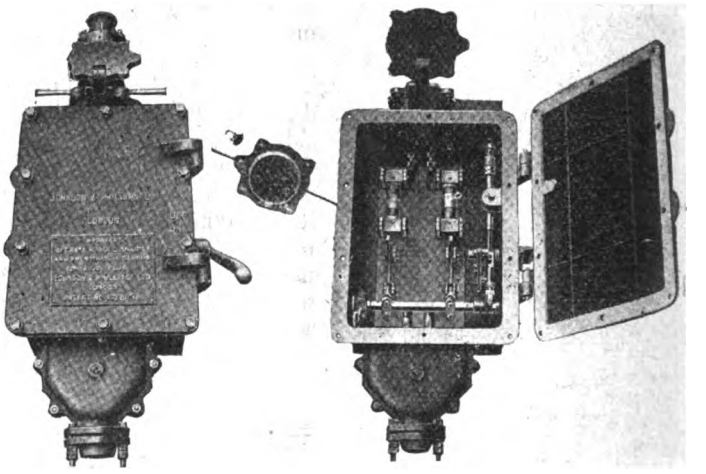


FIG. 2. FIG. 3.

Partnership.—A partnership is announced between Sir Charles Bright, F.R.S.E., F.R.Æ.S., M.I.E.E., F.I.Radio.E., M.Inst.T., Mr. A. Hugh Seabrook, M.I.Mech.E., M.I.E.E., Consulting Engineer (late Chief Engineer and General Manager to the St. Marylebone, London and other Electric Supply undertakings). Mr. A. J. Stubbs, M.Inst.C.E., M.I.E.E. (late Assistant Engineer-in-Chief H.M. Post Office) and Lt.-Col. H. W. Woodall, C.I.E., M.Inst.C.E. (Director and Consulting Engineer of Gas and Water Companies) under the style of Sir Charles Bright and Partners, Consulting Engineers, with offices at 146, Bishopsgate, E.C. 2.

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TELEGRAPHY.—GRADE I. (1921).

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in April, 1921.

(*Continued from page 460.*)

Q. 4.—A full earth fault exists on an overhead line between two stations 30 miles apart. How would you test to determine the position of the fault from one of the stations? Give a diagram of the connections. The resistance per mile of the conductor is known.

A. 4.—The distance of the fault may be found by means of a Wheatstone Bridge set joined up as shown in Fig. 1, the distant end of the faulty wire being disconnected.

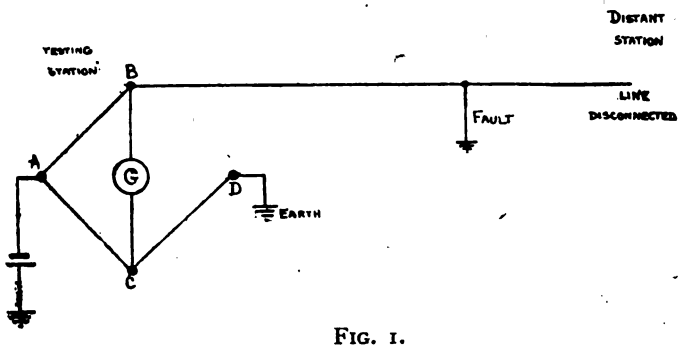


FIG. 1.

The bridge is balanced in the usual way, and assuming that the ratio arms *AB* and *AC* are equal, then the resistance unplugged in the arm *CD*, to effect the balance, will be equal to the resistance of the line up to the fault. This resistance divided by the number of ohms per mile of the faulty wire will give the distance in miles of the fault from the testing station.

The above method assumes that the earth fault has no resistance. In order to eliminate any inaccuracies due to this cause it is preferable to utilise a good second wire, if available, between the twostations for the test, which is then made as follows:—

First of all loop the good and faulty wires at the distant station and measure their loop resistance in the usual way by means of a Wheatstone Bridge. Call this loop resistance *L* ohms.

After making this preliminary test join up the wires to the Wheatstone Bridge as shown in Fig. 2, maintaining the loop connection at the distant station.

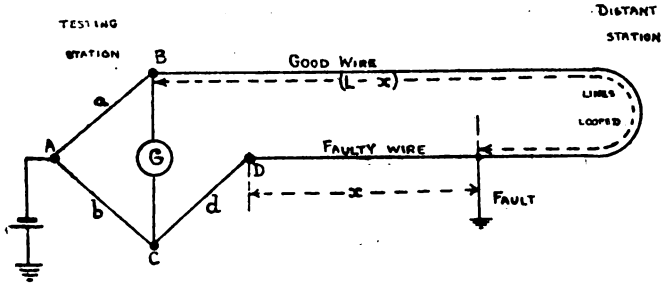


FIG. 2.

Then if x is the resistance along the faulty wire to the fault, a and b the resistances in the ratio arms as shown, and d the resistance required in the arm CD for a balance, by the principle of the bridge we have

$$b \times (L - x) = a \times (d + x)$$
$$\therefore x(a + b) = bL - ad$$

whence $$x = \frac{bL - ad}{a + b} \quad \ldots\ldots\ldots\ldots (1)$$

If the ratio arms, a and b, are made equal, equation (1) reduces to

$$x = \frac{L - d}{2}$$

Dividing the resistance of the wire by the number of ohms per mile, the distance in miles of the fault from the testing station is obtained.

For example, suppose the loop resistance L was found to be 900 ohms, and for a balance in the second part of the test d was 352 ohms. Then if the faulty wire had a normal resistance of, say, 14 ohms per mile, and was of uniform material and gauge, we have

$$x = \frac{900 - 352}{2} = \frac{448}{2} = 224 \text{ ohms.}$$

and the distance to the fault from the testing station would be equal to $\frac{224}{14} = 16$ miles.

(To be continued.)

THE TELEGRAPHISTS' GUIDE. By BELL and WILSON. New (8th) edition, revised and brought up to date by a C.T.O. expert of high standing. 20th thousand. Profusely illustrated. 5s. 6d. net, post free from ELECTRICITY Office. The standard for Grade I.

CONDUIT WIRING.

A NEW CONTINUITY FITTING.

To reduce the cost of conduit wiring by allowing the use of wood patrasses, ordinary wood cased distribution boxes and standard fittings, the Multi-way Patent Earthing Clip Co., 44, Weston Street, London Bridge, S.E.1, have recently introduced in various patterns a simple but most effective device (the Ryeland Multi-way Earthing Clip) for ensuring electrical continuity.

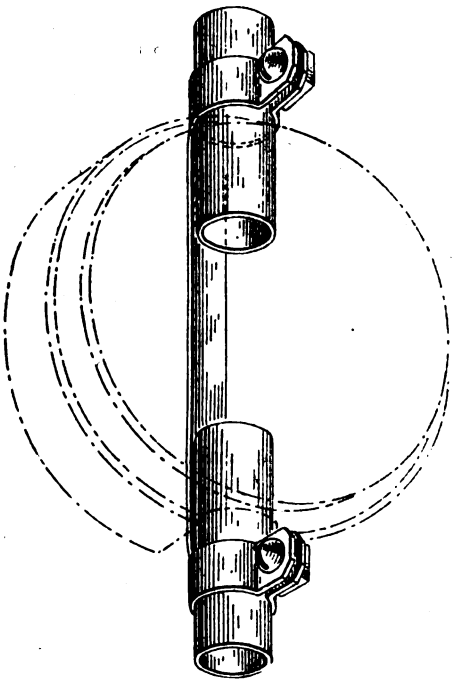


FIG. 1.—PERMANENT TYPE RYELAND MULTI-WAY EARTHING CLIP.

Fig. 1 shows the design used for effecting continuity with the ordinary wood patrass and switch, ceiling rose

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or bayonet fitting. It will be seen that it comprises two clips, which grip the conduit, connected by a metallic strip. Aircraft steel or brass is used, the former being quite as effective as the latter, and also cheaper. The device is pressed from the sheet and is so cut that the edges of the clips have a sharp edge, which cuts most effectively into the enamel on the conduit. It is, however, advised that the enamel be roughly scraped or filed. The holding screw is screwed up with a screw-driver only, the nut not being able to turn. The clip can not, therefore, work loose, and the grip is remarkably effective, as was demonstrated at the recent exhibition at Olympia, where a tremendous weight was supported by the clip. Three holes are now drilled in the middle of the connecting link between the clips to meet requirements for 4-way work.

In another design one clip is on the end of a tail-piece

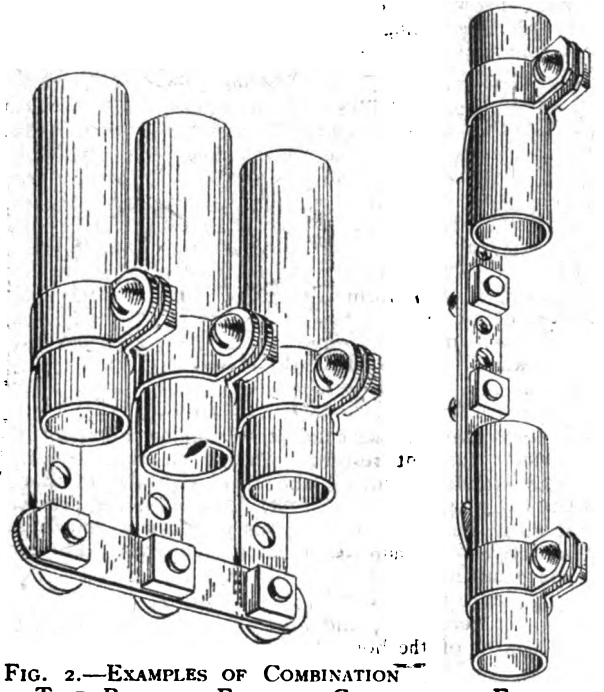


FIG. 2.—EXAMPLES OF COMBINATION TYPE RYELAND EARTHING CLIP.

FIG. 3.

perforated with elliptical holes, at half-inch centres. The tail-piece is made in various lengths, or it may be cut. Plain pieces, without the clips, are also provided. Thus any number of conduits can be connected together, whether they come together in parallel lines, at right angles, or, in fact, at any angle. Thus, it would appear, all wiring requirements are catered for, the clips being made to fit all sizes of conduit.

Figs. 2 and 3 show the principles involved. By careful design of the press-tools a minimum waste of metal is obtained, so that the clip can be sold cheaply. It is not unsightly in use, and works in well with the new Simplex "Terra-Grip" continuity tees, etc.

HYDRO-ELECTRO DEVELOPMENTS.

At the recent British Association meeting, at Edinburgh, the President of the engineering section dealt in his address with the now world-wide important question of water-power development. This we are reproducing practically in full.

In a subsequent paper, Dr. T. F. Wall dealt with the long-distance transmission of electrical energy generated by means of tidal power. He pointed out that the problem of the generation and transmission of electrical energy obtained from tidal power involves serious difficulties on account of the widely varying speeds of the turbines working under a variable head of water. For example, the proposals of the Ministry of Transport for the Severn scheme comprise the use of special direct-current generators driven by the turbines, the direct current being then converted into alternating current by means of rotary converters and then transformed into high-tension current for transmission. Such a scheme involves a very large number of machines and tends to make the proposal prohibitive from the point of view of capital outlay. The purpose of the paper was to describe a scheme in which the difficulty due to the variable speed of the turbines may be obviated, the scheme being based on the characteristic phenomena of quarter-wave transmission.

THE IMPROVEMENT OF INDUSTRIAL LIGHTING.

BY CONTRACTORS SELLING "ILLUMINATION."

A great forward stride in co-operation between manufacturing and contracting interests has recently been made by The Benjamin Electric, Ltd., who are whole-heartedly working with the Trade throughout the length and breadth of the land to supply the demand which undoubtedly exists for correct illumination.

Study of the details of the campaign shows that it is in advance of anything similar so far attempted by our friends across the water—usually regarded as being ahead of the rest of the world in their selling methods—and that it is the logical conclusion of the earlier steps taken by the company's selling organisation. Full details are in the hands of, or will be supplied to, contractors disposed to avail themselves of Benjamin assistance.

Briefly put, the company provide contractors with a complete prospectus of the campaign. This first draws attention to extracts from the H.O. Departmental Committee on lighting in factories and workshops, and then describes what the company will do to assist the contractor to press home to manufacturing interests that, besides its stimulating effect on output, good lighting has the further beneficial effects of decreasing spoilage, preventing accidents, improving discipline and raising the standard of hygiene. The necessity for approaching the right man in order to discuss the lighting question is next considered, and the importance of first determining whether he be the general manager, managing director, works engineer or buyer, is most wisely pointed out. Further, his name and initials must be correctly determined—a considerable time may have to be spent by each of the contractor's representatives in drawing up an accurate list of selected names. Before a personal call is made, letters, type-written or imitation type-written, with the name and address of the recipient typed in if the area covered is too large to warrant the separate typing of each letter, should be sent to the prospective customer by the contractor. The Benjamin Company give the draft for six excellent letters of this kind, together with suggestions for time of posting, the recording of replies, etc. A return postcard should be enclosed with each letter. Of course, the most important factor in the campaign is the personal call, of which the company say in their prospectus :—

"The primary object of the direct mail feature of the campaign is to prepare for lighting sales rather than to make such sales directly. It is not to be expected that letters and folders will induce a great number of factory managers to come to you in regard to equipping their plants with better lighting facilities. Moreover, you should not expect the majority of factory executives on your mailing list even to reply to your letters in every case. However, you may be certain that your advertising messages will get attention, and when you start to call on each of these factory executives, lighting sales will be more easily made, inasmuch as your and our efforts have already paved the way."

In our opinion, the above exactly but concisely states the case, and, moreover, it applies largely to the advertising

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of engineering and labour-saving appliances, etc., in the trade and lay Press.

With regard to Benjamin advertising, it will be remembered that a series of most telling announcements has been appearing, while for the present season trade efforts will be further strengthened by a new series equally effective. In addition the company, under special arrangements, provide quantities of leaflets and folders for enclosing with correspondence, stickers, catalogues, etc., overprinted with the trader's name and address.

One of the best arguments which a representative can use to induce a manufacturer to remodel his lighting equipment is to show him exactly how his present lighting falls short of the mark. Unless, however, his lighting is pretty bad, this is sometimes a difficult proposition. It can be done, however, if the representative has with him some sort of device which will measure precisely the amount of illumination which any plant installation is furnishing. Such a device is the Benjamin Lightmeter, a handy little instrument which will show instantly the intensity of illumination at any point. It is simply placed on the floor or on a bench, and the foot-candle intensity of the illumination at that spot can be read. It is very simple in construction, consisting of a small case containing resistance coils, lamps, and a glass scale on which foot candles are marked. The light from a small lamp of known candle-power offers a means of comparison with the room illumination at the point where the Lightmeter is placed. Contractors can obtain the use of one of these devices, which we hope to describe more fully in another issue.

We do not pretend to have dealt fully with the campaign, but no doubt sufficient has been said to interest those contractors and dealers who are not yet cognisant of the details, and we would advise them to get further information direct from Benjamin Electric, Ltd., at Brantwood Works, Tariff Road, Tottenham, N.17, where are made all Benjamin fittings, reflectors and accessories, and where is situated also the headquarters of the illuminating engineering department, which is available for the assistance of contractors and dealers in the preparation of lighting schemes.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

ELECTRICAL ENGINEERING. By T. E. Wall. 491 pp. 463 figs. (Methuen. 21s. net.)—The purpose of this book is to meet the demand for a complete survey in one volume of the principles of electrical engineering, and the book is intended for students in Universities or in the advanced classes of technical schools, and also as a reference book for electrical engineers in practice. It is essentially a book for the student who wishes to obtain a wide and precise knowledge of the laws and principles of electrical engineering, but the necessary mathematical work is reduced to the simplest possible terms, and the reader is helped immensely by the great number of clear diagrams. Without straining artificially after this aim, as is sometimes done, the author deals with his subject in such manner that the practical applications of fundamental laws and principles are obvious throughout.

The author deals first with the half-dozen fundamental experimental facts upon which—though it is not always realised—the whole fabric of electrical engineering depends. Considerable space is devoted to the subject of static electricity from the engineer's point of view, and this is a good feature of the book because the practical importance of static electricity is now very great in connection with high tension long distance transmission, graded cables, wireless telegraphy, electrostatic separation of materials, and so forth. The connection between the phenomena of magnetism and the magnetic effects of electric currents is made very clear, and this also we think to be a valuable feature of the book. The notes and tables on the magnetic and electrical properties of materials should give the reader a concrete idea of quantities concerning which he is often left in ignorance by volumes dealing with the theoretical side of electrical engineering. Needless to say, the theory is to most engineers only of interest in regard to its actual and possible applications to practice.

Other features which render this book indispensable to the present day student are the treatment given to transient currents, the method of dealing with alternating current problems by means of complex quantities, and the careful explanation of the relations between electrostatic, electro-magnetic, and practical units.

Whilst this book is intended primarily for the student, we feel confident that it will be of great value to many engineers in practice for reference when they are dealing with matters involving precise application of the principles of direct and alternating current electricity, magnetism, and electro-magnetism.

HEATING SYSTEMS. By F. W. Raynes. Second Edition. Cloth 8vo. 324 pp. 158 illus. (Longmans. 21s. net.)—The first edition of Mr. Raynes' book met with such success that a new edition has been called for at a comparatively early date, and it does not therefore need much criticism from us. The author, who is the head of the Department of Heating and Ventilating at the Royal Technical College, Glasgow, has supplied a book which covers the ground very thoroughly, and we have no doubt whatever that it will form the basis of study for all engineers who are associated with the developments of hot water and steam heating apparatus. The old-fashioned open stove was cheerful, but is not efficient. This is a fact which has been discussed *ad nauseum*, and the constant trend of heating systems, at any rate for large units, is to have a central heater with radiators placed where they will give most efficient results. As far as electricity is concerned, it is only touched upon in two parts of the book, namely, pages 15 and 23. Due acknowledgment is made to its convenience for temporary and occasional heating purposes, and admission is made that more can be done in using current if the municipalities can see their way to sell it at a specially low rate. The diagrams given in the book are very clear, and altogether it is well worthy of the reputation of the house by whom it is published.

IDEAL HOMES EXHIBITION—GLASGOW.

Various firms were represented at this exhibition, which was opened recently by Lord Blythswood and the Lord Provost. It is promoted by the Corporation.

Western Electric Co., Ltd., London, have two stands showing labour-saving appliances, including vacuum-sweepers, washing machines, sewing machines, and domestic motors, in which they specialise.

Falkirk Iron Co., Ltd., have a very fine selection of "Falco" cookers, heaters and grates; and the Carron Company, Stirlingshire, gave a fine display of fires, cookers, boiling plates, irons, kettles, etc. This old-established works in Stirlingshire is very much in the forefront with electric specialities for the home, particularly artistic designed fires.

Messrs. C. F. Howden and Co., Glasgow, stage the "Mercury" paraffin engine dynamo set for private house lighting, also various household electric appliances. The Electric Suction Cleaner Co., of Victory Works, Croydon, have a very interesting stand showing cleaners, also drilling machines and small power motors. There are many electric suction cleaners on the market, including the "Magic," of Magic Appliances, Ltd., London, the "Gem," staged by a Manchester firm, also the "Hoover," by the Hoover Suction Sweeper Co., Ltd., London. The Electric Appliances Co., London, show the "Eureka" cleaner.

Large stands are occupied by the Glasgow Corporation Electricity Dept., with special reference to heating, cooking and ironing and everything pertaining to the household.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.

ANSWERS: A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 126.

What are the essential principles to be observed when designing electro-magnetic relays to ensure quick action? I desire to design a relay with 1-100th second period of contact. This is to operate on 12 volts, being connected to this supply through leads having a resistance of 3 ohms. The circuit closed will carry 15 amperes at 40 volts. I would like details of a suitable design with a method of verifying the accuracy of the relay to operate in the period stated. I would also appreciate the name of a technical book or paper from which I can obtain details of designs of this nature.—"B."

QUESTION No. 127.

I desire to have electric light and electric motors fitted in my boot factory. I would like you to point out the most essential features to be considered when drawing up a specification to enable the correct type of motor and fittings to be installed. The supply is 500 volts, three wire.—"Astatic."

(Replies to Questions Nos. 126 and 127 must be received not later than October 29, 1921.)

Various Items.

Reduction in Electrical Charges.—A reduction of 15 per cent. is to be made forthwith in the Cardiff electricity charges. It is generally expected that a further reduction will be announced, the Corporation having saved £3,000 on their coal contracts.

"Priceless" Catalogues.—We are advised of a large contract recently lost to a British firm by the delay in getting even approximate prices to China, though the prospective customer was much impressed by the apparatus described and illustrated in a handsome brochure.

Norway.—We understand that the proposed electrical transmission cable from Norway to Denmark may eventuate in a few years. Besides financial, there are, however, technical difficulties, e.g., it is proposed to transmit at 200,000 volts—a pressure greater than anything so far attempted.

Cardiff.—The Development Agent, City Hall, Cardiff, will send, on request, to manufacturers a handsome illustrated brochure descriptive of the City's inducements as a manufacturing centre. The brochure contains essential matter of interest to manufacturers and other business people, and with it goes a large scale-map of the city and docks.

Lecture Season.—The Electrical Development Association, 84, Kingsway, W.C.2, has a large collection of Lantern Slides dealing with the generation, distribution, and use of electricity for industrial, business and home purposes. The director will be glad to hear from persons desiring to obtain the use of slides for lecture purposes during the coming winter.

The Electrical Trades Benevolent Institution.—The Annual Festival of this institution will be held on Wednesday, October 26th. The Festival Dinner will be held at the Trocadero Restaurant, and will be presided over by Sir Tom Callender. This year the committee have decided to adopt what is an innovation at this annual festival—namely, ladies will be present. It is to be trusted that there will be a large gathering to support Sir Tom Callender, and that the list of contributions to be laid on the table will show a large increase on the lists of the past two festivals.

Agency.—Electrical Contractors throughout the U.K. will be interested in the Lamp agency scheme which is advertised on the small ad. page and they should follow it up.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 7th October, at Caxton Hall, at 8 o'clock. "Color Vision and Colour Blindness," by Dr. Edridge Green, C.B.E. (Slides.) Also on Friday, 14th October, at Caxton Hall, at 8 o'clock. "Electric Cranes," by C. H. Woodfield, M.I.Mech.E. (Member). (Slides).

S.S. "Sophocles."—The s.s. *Sophocles*, the new Aberdeen liner, which was launched at the Abercorn Basin, Belfast, on the 22nd inst., is being built by Harland and Wolff, Ltd., to the order of George Thompson and Co., for the Australian passenger and freight trade. The winches for supplying power to the four derrick posts and eighteen derricks—dealing with weights up to 40 tons—are electrically driven. 1,200 lamps are installed in addition to a number of large cluster fittings and 2,000 c.p. lights for large cargo handling. The electric steering gear is of the "Wilson-Pirrie" pattern, and amongst other apparatus and machinery electrically propelled are the bilge pumps, turbine turning motors, dough mixer, potato peeler, fifteen fans varying from 15 ft. to 35 ft. in diameter, and having motors from 2½ hp. to 15 hp. The ash hoists are electrically driven. The generating plant consists of two turbo-generators, each of 150 kw., and one Diesel emergency set of 75 kw. above the water-line. The *Sophocles* measures 500 ft. in length, has a beam of 63 ft. and a gross tonnage of 12,300. Provision has been made for 150 first-class passengers and 424 third-class passengers. A sister ship, the *Diogones*, is well forward, and will be ready for launching early in the New Year.

Trade Notes.

A folder from **Chas. H. Champion** (Moorgate Station Chambers, E.C.2.), describes various carbons for A.C. and D.C. arc lamps, open, enclosed and flame types, as well as "Ship" carbons for kinematograph work.

A new Catalogue section (X3, 13th edition) has been issued by the **G. E. C., Ltd.**, illustrating and describing, with dimensions, drawings and full particulars, open type and ironclad circuit-breakers, auto-battery cut-in and cut-out sets, time-switches and current limiters. Prevailing prices are given on an accompanying leaflet, dated June 1, 1921.

The British Cellulose and Chemical Manufacturing Co., Ltd. (8, Waterloo Place, S.W.1), manufacture a new safety celluloid which is non-inflammable and safe to use. It takes the place of explosive celluloid satisfactorily, and is made by British labour. This is of particular interest at the present time, as the Home Secretary has recently promulgated a stringent set of regulations under the provisions of the Factory and Workshops Act, 1901, dealing with places in which celluloid or any article partly made of celluloid is manufactured, manipulated or stored.

The Bastian Electric Co., Ltd. (185, Wardour Street, W.1), issue a folder describing and pricing "Quartzalite" electric fires in period designs, as well as for industrial purposes. Included also are Bastian storage geysers, a "Pyro-stove" for boiling, stewing, grilling and frying, baking oven, and the Bastian Crucible Muffle and Tube furnaces, etc. The furnaces are for temperatures up to 1100° C. (2000° F.), and the heating element is wound round the furnace chamber as a close spiral with the contiguous turns touching. The wire is coated with a refractory oxide which prevents short-circuiting.

The latest designs in "Floodlight" projectors made by the **British Thomson-Houston Co., Ltd.** (Mazda House, 77, Upper Thames St., E.C.4), are fully described in a new list. "Floodlighting" provides a most effective and economical means of concentrating light on such objects as advertisement hoardings, monuments, public buildings, etc., besides being a necessity on shipboard. Mazda gasfilled lamps are used in the projectors, which are made in a variety of designs and sizes. A large poster outside Olympia was thus lighted, as it has been on previous occasions, while the projectors could be seen on the B.T.-H. stand inside the building just by the main entrance.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
OCTOBER 7, 1921.

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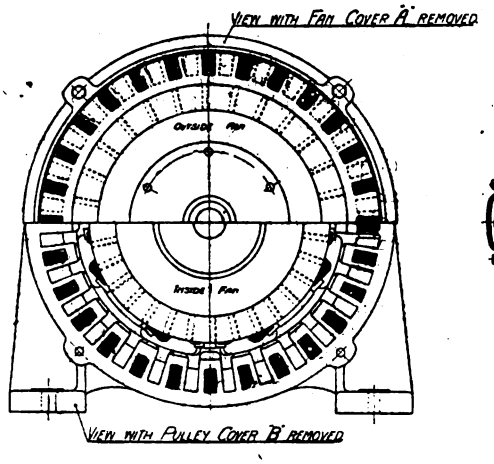
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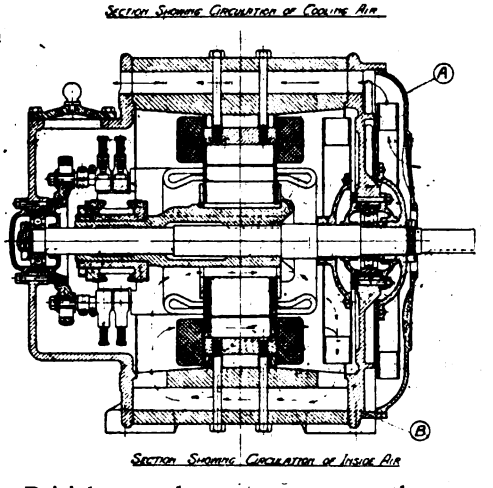
"EMCOL" AND OTHER MOTORS.

At the recent Engineering Exhibition at Olympia the New British Electric Supply Co., Ltd. (Finsbury Court, Finsbury Pavement, E.C.2), showed several types and sizes of "Emcol" totally enclosed motors. The principal feature of these machines, it will be recollected, is the patented system of cooling, which more than doubles the output obtainable compared with ordinary T.E. motors, that is to say, size for size, ordinary open type and "Emcol" motors give the same output. Reference to the sectional diagrams reproduced will show how the cooling is effected. Tunnels or ducts are cast in the magnetic ring which surrounds the motor; in other words, the yoke is cast in two annular rings held together by a number of distance pieces which form the walls of the tunnels. Each ring carries half the flux. Alternate tunnels break through into the inside of the motor. The end covers are made with half as many holes as there are in the body, so that those tunnels which have passages into the body are blocked to external air; the remaining half form holes straight through the yoke, through which cold air from a fan is passed. The internal hot air circulates only through the tunnels (shown in white on diagram) in a completely closed circuit, passing through the motor and back through the tunnels, as indicated by the arrows. The motor is totally enclosed, that is to say, no air can pass from the outside to the inside of the motor. The cooling air passing through the tunnels in the yoke (shown in black on diagram) and out again does not enter into the motor, but merely cools the carcase. By this arrangement the effective cooling surface of the motor is increased, thereby allowing of the augmented output referred to above. A.C. or D.C. machines are made and find application particularly in fiery mines, collieries, ships, chemical factories, cement works, cotton and sawmills, etc. For fiery mines special terminal boxes and glands are supplied. Standard ratings are between 2½ h.p. at 750 up to 65 h.p. at 850 r.p.m. D.C.; and 1 h.p. up to 50 h.p. at 1,500 r.p.m. A.C. Machines are built for standard speeds of 1,500, 1,000 and 750 r.p.m. A.C.

A special feature of "Emcol" machines is also to be found in the brush holders. These are of the box type, substantially made, have a simple screw arrangement for keeping the pressure on the brush constant when once adjusted, have a special arrangement for connecting up the lead, and if the brush be removed the spring cannot fall out, though it may be easily removed by a few turns and as readily inserted. The only tool necessary for any operation is a screwdriver, yet everything is locked in position against the effects of vibration.

The B.K.B. motors which were also exhibited by the company at Olympia are made for D.C. in ratings between 1-10 to 1½ h.p. at various speeds. They are available both series or shunt wound, have ring lubrication fitted, and may be said to be excellent British products, as are the remarkably neat "Featherweight" totally enclosed D.C. motors, which are made in sizes from 1-100 up to ⅛ h.p. These have a particularly fine finish, have ball bearings, laminated fields, and are, in fact, excellent in all details.





Ladies' Night.—The Eleventh Annual Ladies' Night of the Birmingham and District Electric Club will be held at the Grand Hotel on Saturday, October 22. The President, Mr. A. C. Wynne, will hold a reception at 6.30 p.m., followed at 7 p.m. prompt by a concert. An attractive musical programme has been provided. A charge of 6s. per head will be made, which will include light refreshments during interval. Members are requested to bring as many friends as possible. Morning dress will be worn.

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TRAMCAR ACCIDENTS.

ACTIONS FOR AVOIDANCE.

On July 31 a tramcar fitted with two 22.5 h.p. motors, double purchase hand brake, operating blocks on all four wheels; track brake, with two ash shoes each 18 in. long by 2½ in. wide, applied by hand wheel; and electric emergency short circuit brake operated by reversing handle, got out of control after a shower on a gradient in Tynemouth, with fatal results. As a result of the subsequent inquiry by Major G. L. Hall, R.E., Director General Public Safety and Gen. Purposes Dept., Ministry of Transport, several recommendations are made including the following:—"A longer and more thorough and individual training of motormen and conductors, and a more rigid examination before the issue of certificates, combined with periodical re-examination, is necessary.

"It will be desirable to experiment with a slipper block having a greater total area available for contact with the rail, by increasing either the length or breadth or both. Conditions of curvature, etc., impose a limit on these dimensions beyond which it is not possible to proceed, but it is, I think, probable that some extension can be made. There are, for example, undertakings which use slipper blocks 3 ft. long. I think, too, that the diameter of the wheel by which the slipper block is applied should be increased. In making these recommendations, it is only right to say, as I have already indicated, that the existing equipment has been approved in the past, and I make the recommendations for the sake of providing additional security in view of the recent accidents which have occurred. In regard to the short circuit emergency brake fitted to these cars, although this may have been accepted in the past, it is not now accepted in the case of new cars as an 'adequate electric brake,' and it is, therefore, very desirable that all cars . . . should be fitted . . . with equipment which includes a rheostatic brake."

In connection with the first recommendation reproduced above, the responsibility of motormen and conductors to treat their important duties in all seriousness cannot be over-emphasised, and if the "Instructions to Conductors" issued by the Coy. in question had been properly studied by the conductor of the car to which the accident occurred it would probably not have had the fatal termination which it did.

The following are the "Instructions to Conductors as to How to Act when a Car is Out of Control, and the Motorman is in Difficulties":—

How to know when the car wheels are skidding:—By the sliding motion of the car, or by the "sissing" noise at the wheels. When skidding is observed conductors must note whether the motorman is in difficulties or not.

Car out of control going down hill:—As soon as the conductor realises that the car is getting out of control going down hill, he will apply the track-brake as tight as it will go. Under these circumstances DON'T apply the hand-wheel brake. DON'T knock the canopy-switch off. DON'T pull the trolley off. When travelling in this direction it would be useless to apply sand at the rear platform.

Car running back down hill:—As soon as the car commences to run back, the conductor must apply the track-brake as tight as it will go. He will then insert the sand-pin and work it briskly so as to get a good flow of sand to the rail. Again, under these circumstances DON'T apply the hand-wheel brake. DON'T knock the canopy-switch off. DON'T pull the trolley off. Should the automatic switch blow out above the conductor's platform, he will replace it at the direction of the motorman. Should the motorman require the conductor to apply the hand-wheel brake at the rear end he will give the three bells signal.

Should anything happen to the motorman causing him to be unable to operate the handles, and the car is in motion with the power on:—It is most important that the conductor should promptly observe if the car is travelling on a level road, or whether it is going up hill or down hill, and then to act according to the following instructions, whichever is the most applicable:—

(1) Should the car be going up hill, the conductor will smartly proceed to the front platform and allow the power to remain on until the car reaches a point of safety on the level, and then shut off the power and apply the hand-wheel brake.

(2) Should the car be going down hill or along a level road and the conductor is on the upper deck at the time, he will smartly proceed to the front platform and first see that the power is off, and apply the track-brake as tight as it will go, and then put on the hand-wheel brake as well.

If the conductor is inside of the car or on the rear platform, he will apply the rear track-brake as tight as it will go, and then put on the hand-wheel brake as well.

NORTHAMPTON POLYTECHNIC INSTITUTE.

At the Northampton Polytechnic Institute, St. John Street, Clerkenwell, E.C.1, the new session in the evening courses and classes started on the 26th ult. The day courses and classes started this week, the entrance examinations having just been held. The enrolments last session were more numerous in all courses and classes than in any pre-war session, and many applicants for evening work had to be placed on waiting lists.

Very substantial additions were made to the already excellent equipment during last session owing to a liberal grant of the L.C.C., and a further grant will be expended during the current session.

The programme of the work for the new session now resumes its full pre-war aspect, and it is confidently expected that the enrolments will again justify the submission of the comprehensive programme which has just been sent us. The courses in the Engineering Day College are the full four-year courses so familiar to engineers in pre-war times, and in all these there are indications that the enrolments will again be heavy. In the evening classes in engineering the regular classes are announced, and as will be found at page 150 and elsewhere in the "Announcements," short courses of lectures in special subjects will be given during the session; ample notices of these courses will, we understand, appear in the technical Press.

In all the depts., including Civil and Mechanical Engineering, Electrical Engineering, Optical Engineering, Technical Chemistry, Horology and Women's Trades, the programmes of the various classes have been brought up to date.

The Principal of the Institute and also the head of the the Electrical Engineering Dept. is Dr. R. Mullineux Walmsley, who is assisted by a large and able staff.

THE CO-OPTIMISTS.

To mark the close of the Shipping, Engineering and Machinery Exhibition at Olympia, a dinner was held on Tuesday evening, September 27, under the chairmanship of Capt. H. Riall Sankey (President Inst. Mech. Engrs.).

The speakers, one and all, expressed remarkable optimism in the success about to attend the engineering industry by the signs of the spirit of hearty co-operation between employers and employed which, as Mr. W. A. Appleton (Sec. Gen. Fedrn. of Trade Unions), backed by T. Chambers (Nat. Saliors' and Firemen's Union of Gt. Britain and Ireland), emphasised, is now manifest in spite of the apparently cloudy horizon. These leaders of labour fully recognise that workmen can only realise their just desire for a profitable share in the control of industry by co-operative effort combined with mutual understanding and not by any kind of revolution. Further, wages can only

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be determined by the value of things produced to the buyer and *not* on the cost of living. It was further emphasisd that rates and taxes *must* be reduced. Other speakers were Dr. H. S. Hele Shaw, Mr. W. Reavell (M.I.Mech.E.), Mr. W. H. Patchell (M.Inst.C.E.), Mr. G. Midgley Taylor (M.Inst.C.E.), and Mr. F. W. Bridges, the organiser of the exhibition and of the dinner, from which the large and distinguished gathering of employers and employed could not depart without a feeling of knowing one another better.

Mr. Bridges remarked that at this exhibition there had been a larger attendance from at home and abroad than at any preceding engineering exhibition. Many employers had arranged visits for their employees, one providing facilities for 2,000.

Hearty congratulations to Mr. Bridges on the success attending his worthy efforts.

THE "LIGHTNING" COOKING OVEN.

The "Lightning" electric oven (Fig. 1) is manufactured by Electrical Utilities, Ltd. (1–3, Shelgate Road, Battersea Rise, S.W.11), under the patent taken out by Mr. N. Prentice (engineer and manager of the East Anglican Electricity Co., Ltd.) with some additional improvements. It is efficient and economical in use, but, as may be seen, it is an oven only, and not a cooker.

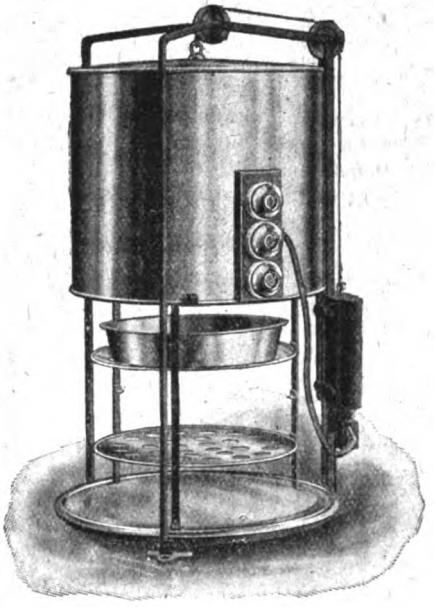


FIG. 1—"LIGHTNING" OVEN TYPE "C."

It consists essentially of a circular polished aluminium dome, inside of which, carried circumferentially, is the heating element extending from top to bottom and divided into three sections. The element is seen in Fig. 2 and a diagram of the control in Fig. 3. It can be traced out that five heats can be obtained, particulars being as follows :—

Top Switch	on	off	off	on	on
Middle ,,	on	on	off	on	off
Bottom ,,	on	on	on	off	off
Heat	full	high	medium	medium	low*
Element in Circuit	all	lower half	bottom	top	all
Temp. °F.	very high	450	300	300	220
†Units used in 15 min.	½	⅓	⅙	⅙	1/20

*All heat is radiant except "low."
†Larger size (type "A") see next column.

Thus all conditions for the successful roasting of meat, cooking of pies, potatoes, milk puddings, etc., and for cake baking are met. Special tins for various purposes are supplied.

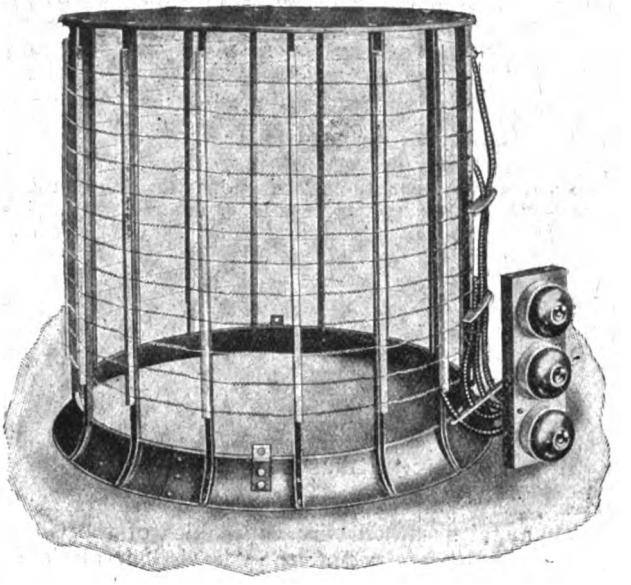


FIG. 2—ELEMENT.

The oven is made in two types, "A" and "C." The latter is illustrated. It has a single wall, is suitable for families of 4–5 persons, it cooks joints up to 15 lb. weight, and is loaded to 1,600 watts. Type "A" has twice the volume, is loaded up to 2,000 watts, and has a double wall. Apparently, therefore, the company, like

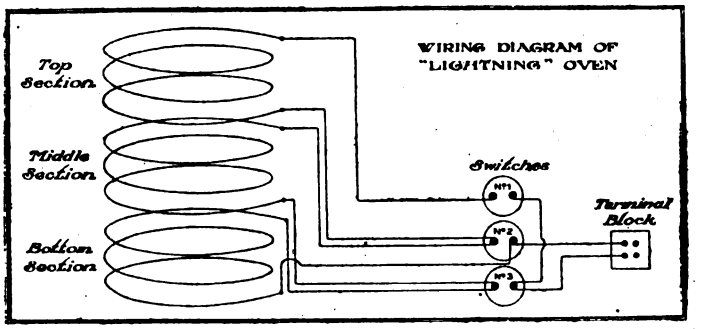


FIG. 3—WIRING DIAGRAM.

others, do not believe that the additional complication of a double wall in small utensils is justified in practice.

It will be noted that by surrounding the joint with the fire, so to speak, the principle of the old-fashioned Cooking Jack is revived in a more efficient form. No one can say that the Cooking Jack did not roast meat perfectly, though that method was uneconomical of fuel. Whereas in the oven being considered a very high efficiency is obtained.

In addition to what has been said one point is of special note. When the dome is raised for inspection of the viands, the heated air rises with it and but little loss of heat takes place.

Blackpool.—The Electricity Committee has approved extensions at the Electricity Works estimated to cost about £150,000.

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THE KINGSWAY WIRING SYSTEM.

In designing their new wiring system—the "Kingsway"—the General Electric Company, Ltd., have kept before them not only the necessity of complying with the exacting and often conflicting requirements demanded of such a system, but also the desirability of reducing the number of special accessories and parts to a minimum. Such apparatus as switches, distribution boards, ceiling roses, etc., are all of the ordinary standard patterns.

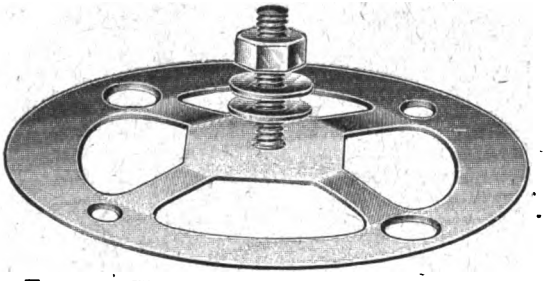


FIG. 1.—THE "KINGSWAY" BACK-PLATE.

Briefly, the "Kingsway" is a surface wiring system in which metal sheathed wire and cables of the Class L.I. grade, manufactured at the Pirelli-General Cable Works, Southampton, are employed. The wires are fixed to the walls and ceilings by saddles or wiring clips. All connections are made by means of insulated connectors, and the continuity of the metal sheathing is effected by continuity clips attached to a special back-plate. Joints and back-plates are covered either by a "Kingsway" universal junction-box cover, or by a wood pattrass.

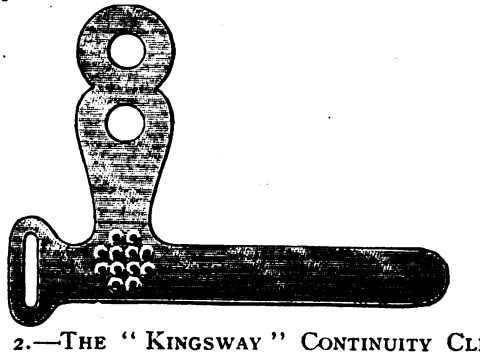


FIG. 2.—THE "KINGSWAY" CONTINUITY CLIP.

Details of the various components are as follows:—

Fig. 1 shows a tinned brass back-plate. The centre screw acts as an earth terminal, and also for fixing either the "Kingsway" junction box-cover or a wood pattrass. Two washers and a clamp nut are provided to secure the continuity clips, and two large and two small holes in the base allow for fixing in any position.

The "Kingsway" continuity clip (See Fig. 2) has been designed to avoid the use of independent bonding clamps. Only one size is required for providing adequate bonding of the metal sheathing, whether the cables enter the junction-box or wood pattrass from the side or back. When the cable enters from the side, the hole nearer the end is threaded on to the centre screw of the back-plate. For back entry, the second hole is used, and the overlap broken off.

In Fig. 3 is shown a "Kingsway" back-plate with wires and connectors in position. The method of bonding is clearly seen. Fig. 4 shows a complete universal junction-box. The cover can be easily and quickly adapted, without the use of special tools, for any number of entries up to four, by bending upwards and inwards the tongues of metal formed between the slits in the wall. Four sets of three slits are provided, allowing for single, twin or three-core cable. A milled nut is provided for fixing, and is permanently attached to the cover to avoid loss.

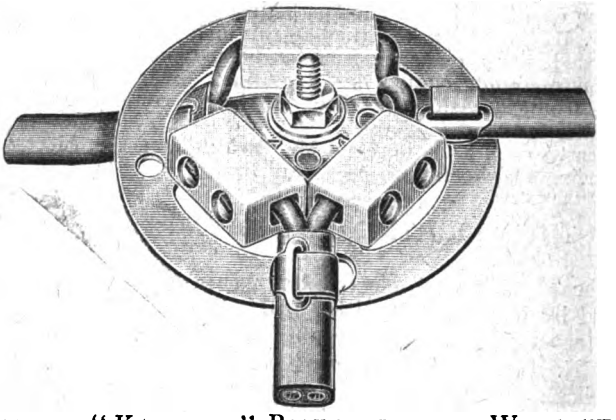


FIG. 3.—"KINGSWAY" BACK-PLATE, WITH WIRES AND CONNECTORS IN POSITION, SHOWING METHOD OF BONDING.

The wiring clips (Regd. No. 683712) used are constructed of soft tinned brass, and the fixing hole is countersunk so that the heads of screws or fixing pins cannot project above the surface of the clip and cause injury to the metal sheathing of the cable.

For use at the back of fuse-boards, multiple switch boards, and other positions where it is necessary to bind several cables together, special earthing bars are recommended. These are made of stout tinned brass strip, and the connections are made by means of the "Kingsway" continuity clip (Fig. 2), which is attached by a flat-headed countersunk screw. A substantial terminal with nut and washers is provided for the earth connection.

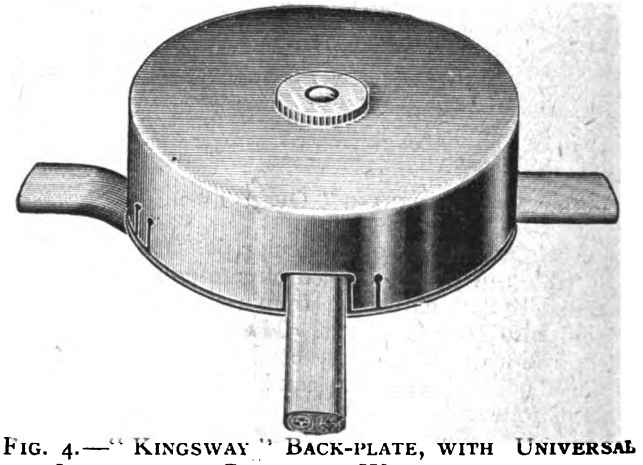


FIG. 4.—"KINGSWAY" BACK-PLATE, WITH UNIVERSAL JUNCTION-BOX COVER AND WIRES IN POSITION.

The G.E.C. have just issued a catalogue (Section W12) giving a complete description of the system, with prices of the various suitable accessories and materials. A copy can be obtained on application to the company, at Magnet House, Kingsway, W.C.2, or any of its provincial branches.

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PAGES FROM OUR DESIGNER'S NOTEBOOK

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WESTON WORKMANSHIP.

A CONTRAST.

In the design and construction of all WESTON instruments the utmost attention is devoted to the production of a moving element of minimum weight and maximum strength; one, in short, which combines delicacy and a high degree of sensitiveness with mechanical qualities that will enable it to withstand all but the severest abuse.

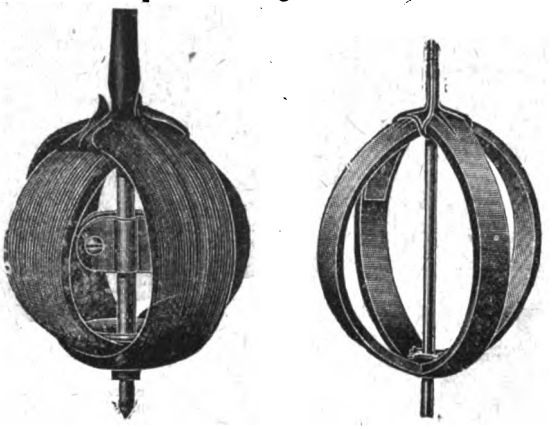
This necessarily entails a very high standard of manufacture never found in low-priced instruments of the ordinary type, and the difference between WESTON workmanship and that put into many electrical instruments of this class is well exemplified in the accompanying illustrations, which are in no way exaggerated.

On the left is a reproduction which shows the common way of constructing the movable coils of a Power Factor Meter. The two coils are wound separately, and one is slipped inside the other, the whole being roughly mounted on heavy spindle.

Such construction is inherently wrong; it is impossible to get even approximate magnetic equality with two such coils and, in addition to being too heavy, this type of construction makes no provision for the establishment or maintenance of a definite relative position of the coils.

On the right is shown the WESTON method of construction, which is totally different and quite unique. The coils are wound by special machinery and interlaced layer for layer at diametrical crossing points. They are then treated with a special cement which gives them great rigidity and assures permanent angular relation of the coils.

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COMPARISON OF ORDINARY AND WESTON CONSTRUCTION OF POWER FACTOR METER MOVABLE COILS.

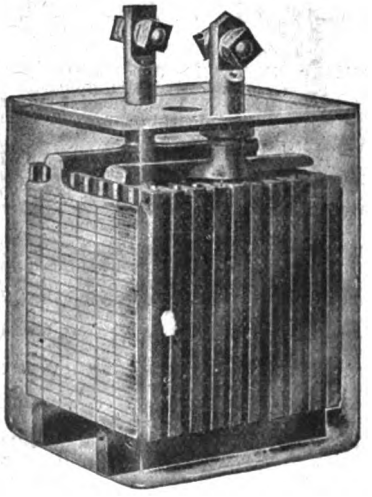
In result, the coils are identical in magnetic strength when traversed by the same current, and are accurately and permanently fixed in planes at right angles to each other. For full particulars of the Power Factor Meter write for Catalogues.

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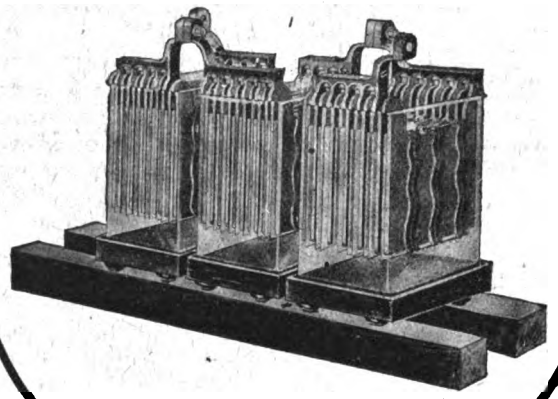
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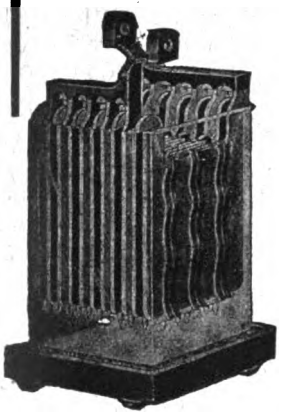
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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones must reach the publishing office not later than the first post Tuesday morning, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription.—17s. 6d. a year, 8s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 93-99, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

The Supersession of the Tram.

Coming events cast their shadows before, and, if the atmosphere at the recent conference of the Municipal Tramways Association, held at Salford, is anything to go by, the days of the tram as a means of passenger transport in busy cities and towns are numbered. For some considerable time past I have commented on the passing of this means of locomotion, which has served the public well for a number of years; but, due to its limitations, initial expense and upkeep, coupled with the lack of flexibility of the system and the obstruction it constitutes in busy streets, it is no longer able to compete with more up-to-date methods of passenger transportation. According to the secretary of the Association, "tramways are in a backwater." Last year they showed in all parts of the country a deficit of more than £2,356,000. The rapid development and extension of motor omnibus services have done as much as anything to hasten their doom, and the trackless trolley system, which is a practical alternative, has not received the attention it deserves.

Even in America, tramway undertakings are feeling a draught, as evidence the case of Des Moines, Ind., which is now without a street car service, and likely to continue so for some time. According to an American contemporary, the voice of the people has been insistent for fares that do not pay cost of operation, and the politicians have acted along the path of least resistance. Complaints were rife at the annual conference above referred to regarding the so-called "unfair" competition of independent motor vehicles, and a resolution was moved stating that the motor competition, inequitable concerning local taxation, road maintenance, workmen's and ordinary fares, and regularity of service, would increase tramway costs, and consequently fares. It was, therefore, suggested that the Ministry of Transport be urged to regulate such motor competition in the public interest.

With all due deference to the M.T.A., I very much doubt whether such an attempt to stifle competition would actually be in the public interest. The public wants to be carried as cheaply as possible from point to point, in reasonable comfort, and, if the tramways are unable to cope with this urgent need, then they have no right to seek monopolistic powers such as are indicated by the resolution above referred to. I have every sympathy with the tramway supporters as advocates of an obsolescent system of transport, but the world must progress, and competition is good for us all. Furthermore, some tramway undertakings fail to realise the growth of the traffic in their areas, and neglect to take the necessary steps to cope with public demand. There is a case in point from Liverpool, where a correspondent writes me concerning a complaint he recently submitted to the Corporation Tramways Department.

It seems that, on a certain route in that city, six cars passed from an outward terminus, all to scheduled time, but filled to overflowing with passengers, and incapable of accommodating any intermediate traffic. A courteous statement of the facts, and an appeal for improved facilities, brought the somewhat unreasoning reply from the management that, as the cars in question had actually passed that point, it was proof positive that "there was a frequent service of cars on this route." The mere fact that there was no accommodation for anyone wishing to travel was apparently a secondary consideration. It is this attitude on the part of tramway managements which tends to aggravate the situation of which their sponsors complain to-day.

The trouble with any street transport system is that it is incapable, to a greater or lesser degree, of coping with the busy hour load. There are certain hours during the day, in every city or town of any magnitude, when the bulk of the population are abroad and want to be carried, either to or from their homes, in the shortest possible time and at the lowest cost in reasonable comfort. In meeting this need the tramway is the worst handicapped of any existing system; it cannot concentrate its cars conveniently at short notice at any given point, and, moreover, it constitutes an obstruction to all other traffic on the roadway. The trackless trolley 'bus has advantages in that it can negotiate the traffic with far less obstruction, and makes for readier concentration of cars when needed. The independent motor vehicle has the pull over both, inasmuch as it can go wherever there is a road to take it, pick up and set down its passengers at the footwalk, can be concentrated in any desired numbers at given points at short notice, and maintains a higher average speed.

Moreover, the motor omnibus is cheaper in prime and running costs than the tramway, and better able to cope with busy hour traffic. For all this, I do not think we have yet reached the ideal form of surface transport for busy cities. Carrying the public by any kind of vehicle involves splitting up the crowd into small packets of 30 to 100 passengers at a time, coupled with the loss of time incidental to loading and unloading these isolated groups. The ideal system, and one which our grandchildren may live to see, will undoubtedly be a development of the moving platform principle whereby passengers between various central points in a populous area will simply step on to a species of moving belt travelling at a walking pace, and thence on to central platforms moving at a higher rate of travel, reversing the process as they approach their destination. Thus the load will be distributed over a series of travelling belts, with no overcrowding

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or strap-hanging; just an easy, gliding motion without jostling or queuing up for the chance to get home.

Fruity.

It is announced that the first electrically driven fruit ship to be built in Ireland is a 3,600-ton vessel, the *San Benito*, built by Messrs. Workman, Clark and Company, Limited, Belfast. She is designed for the banana trade, burns oil fuel, and is turbo-electrically equipped. It is curious to reflect that, while carrying bananas, she will be propelled by curr(a)nts.

They Don't Mix.

At a recent Oldham Gas Committee meeting there was produced a short length of gas service pipe in the side of which a hole had been fused, so it was alleged, by an electric wire placed close to the gas-pipe. The pipe was taken from a bedroom, and it was further stated that the resultant leakage of gas nearly suffocated a girl who was sleeping in the room. It was decided to bring the matter to the notice of the Electricity Committee with a view to reminding electricians that electric wires should not be placed too near gas-pipes. They have always been jealous of one another these two, and it was only natural that the gas, thus liberated by its rival, should try to revenge itself on an innocent consumer. Incidentally, the roseate predictions concerning cheap electricity in the future have not been without their effect on gas interests, for in the president's address to the British Commercial Gas Association at Glasgow, he remarked that competition between gas and electricity was likely to be even greater in the future, and foreshadowed a reduction in the price of gas to cope with the situation. Measuring it out by the "therm" has put our friends on their mettle.

Trade and the Press.

I was glad that among the subjects dealt with in his presidential address to the British Association of Trade and Technical Journals Mr. E. M. Iliffe insisted on a wider recognition of the part which trade and technical newspapers are playing in regard to the development of British commerce. On trade matters the query should not be: "What does the Press think?" but: "What does the trade and technical Press think?" To this end it must be made thoroughly known that there is a body that is able to speak for the trade and technical Press of the country.

Among the matters on which the B.A.T. and T.J. should be consulted might be mentioned two as examples: the British Empire Exhibition which is being organised for 1923 at Wembley Park and the British Empire Trade Exhibition Ship. Another matter referred to by Mr. Iliffe was the important part played by the association in persuading the P.M.G. of the harmful effects on trade if the prohibitive foreign postal rates recently proposed were carried into effect.

ELEKTRON.

Smoking Concert.—The First Electro-Harmonic Smoking Concert of the season will be held in The Great Hall, Cannon Street Hotel, on Friday, October 14, at 8 p.m. It is hoped that members will be present in force as a really first-class programme has been provided

ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to Questions set at the 1921 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page 521.*)

Q. 4.—Compare the advantages of two- and three-phase systems in relation to generation, transmission and distribution. Give your remarks in the form of a table.

A. 4.—In regard to generation there is practically no difference between two- and three-phase systems. The generators have the same efficiency and regulation for the same power and speed, and any slight difference in the cost of the switchgear depends mainly upon whether the 3-wire or the 4-wire two-phase system is being employed.

With reference to transmission, the basis of comparison between the different systems depends upon whether the maximum voltage is limited by the dielectric strength of the insulation between two conductors or of the insulation between one conductor and earth; thus, in the case of a cable system in which all the conductors are enclosed in the same cable, the principal factor in determining the maximum voltage is the insulation between the conductors. Similarly with an unearthed overhead transmission line, if one conductor temporarily becomes earthed, and it is essential to maintain continuity of supply, the line voltage must be taken as the basis of comparison. In an overhead system with earthed neutral, however, and in moderate-potential power circuits where danger to life from live wires must be considered, the proper basis of comparison is the maximum voltage to earth.

For transmission purposes, only the following systems need be considered:—

(A) Two-phase 4-wire system with the phases interlinked at the mid-point of each phase, this point being earthed.

(B) Three-phase 3-wire system with star point earthed.

(C) Two-phase 4-wire system, unearthed.

(D) Three-phase 3-wire system, unearthed.

The two-phase 3-wire system need not be considered for transmission of electrical energy since even with a balanced load the voltage drop in the two phases are not the same, so that the system is unbalanced in regard to both voltage and phase relation—*i.e.*, at the end of the line the two voltages are neither equal in magnitude nor in quadrature with each other.

For systems (A) and (B) above, the *maximum* voltage to earth will be limited to v volts, whilst for systems (C) and (D), the *maximum* voltage between conductors will be limited to the same value. Let A_1, A_2, A_3 and A_4 be the sectional area per conductor for the various systems; then the resistance per conductor is $\frac{k}{A_1}$, etc., when k is a constant for a given length of transmission line. We shall now calculate the relative

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sectional areas of copper required by the above four systems to transmit a certain power P at unity $P.F.$ with the same efficiency, *i.e.*, with the same line loss.

SYSTEM.	A.	B.	C.	D.
Effective volts between line conductors.	$\sqrt{2}\,v$	$\frac{\sqrt{3}}{\sqrt{2}}v$	$\frac{v}{\sqrt{2}}$	$\frac{v}{\sqrt{2}}$
Line current	$\frac{P}{2\sqrt{2}\,v}$	$\frac{\sqrt{2}\,P}{3v}$	$\frac{\sqrt{2}\,P}{2v}$	$\frac{\sqrt{2}\,P}{\sqrt{3}\,v}$
I^2R loss per line	$\frac{1}{8}\left(\frac{P}{v}\right)^2\frac{k}{A_1}$	$\frac{2}{9}\left(\frac{P}{v}\right)^2\frac{k}{A_2}$	$\frac{1}{2}\left(\frac{P}{v}\right)^2\frac{k}{A_3}$	$\frac{2}{3}\left(\frac{P}{v}\right)^2\frac{k}{A_4}$
Total line loss	$\frac{1}{2}\left(\frac{P}{v}\right)^2\frac{k}{A_1}$	$\frac{2}{3}\left(\frac{P}{v}\right)^2\frac{k}{A_2}$	$2\left(\frac{P}{v}\right)^2\frac{k}{A_3}$	$2\left(\frac{P}{v}\right)^2\frac{k}{A_4}$
Ratio of sectional area per line	$\frac{1}{2}$	$\frac{2}{3}$	2	2
Ratio of total weight of copper, *i.e.*	2 1	2 1	8 4	6 3

The latter part of the above table may require a little explanation: Since the total line losses of the different systems are being assumed equal, then—

$$\frac{1}{2}\left(\frac{P}{v}\right)^2\frac{k}{A_1}=\frac{2}{3}\left(\frac{P}{v}\right)^2\frac{k}{A_2}=2\left(\frac{P}{v}\right)^2\frac{k}{A_3}=2\left(\frac{P}{v}\right)^2\frac{k}{A_4}$$

$$\therefore \frac{1}{2A_1}=\frac{2}{3}\cdot\frac{1}{A_2}=\frac{2}{A_3}=\frac{2}{A_4}$$

$$\therefore A_1 : A_2 : A_3 : A_4 = \frac{1}{2} : \frac{2}{3} : 2 : 2.$$

i.e., $A_2=\frac{4}{3}A_1$; $A_3=4A_1$; and $A_4=4A_1$.

Hence total area for system (A) $= 4A_1$
" " " (B) $= 3A_2 = 4A_1$
" " " (C) $= 4A_3 = 16A_1$
and " " " (D) $= 3A_4 = 12A_1$
so that ratio of copper for the four systems is—

1 : 1 : 4 : 3.

The 3-phase system, however, has a distinct advantage over the 2-phase 4-wire system in that the cost of erecting a 3-wire system or of constructing a 3-core cable is appreciably less than that of the corresponding 4-wire system having the same volume of copper.

In distribution circuits, the potential is limited not by the insulation strain but by the potential of the apparatus, such as incandescent lamps, etc., connected to the system; so that the proper basis of comparison is the equality of the minimum difference of potential—*i.e.*, the voltage per branch or per phase of the system. We shall, therefore, consider the following alternatives :—

(A) Two-phase 3-wire system with V volts (r.m.s.) per phase.

(B) Two-phase 4-wire system with V volts (r.m.s.) per phase.

(C) Three-phase 3-wire system with V volts (r.m.s.) across line.

(D) Three-phase 4-wire system with V volts (r.m.s.) per phase.

Let P be the power to be distributed at unity PF, and suppose this load to be shared equally between the various phases; then we can calculate the following table :—

SYSTEM.	A.	B.	C.	D.
Line current.	$\frac{P}{2V}$	$\frac{P}{2V}$	$\frac{P}{\sqrt{3}\,V}$	$\frac{P}{3V}$
I^2R loss per line	$\frac{1}{4}\left(\frac{P}{V}\right)^2\frac{k}{A_1}$	$\frac{1}{4}\left(\frac{P}{V}\right)^2\frac{k}{A_2}$	$\frac{1}{3}\left(\frac{P}{V}\right)^2\frac{k}{A_3}$	$\frac{1}{9}\left(\frac{P}{V}\right)^2\frac{k}{A_4}$
Total line loss	$\frac{1}{2}\left(\frac{P}{V}\right)^2\frac{k}{A_1}+\frac{1}{2}\left(\frac{P}{V}\right)^2\frac{k}{\sqrt{2}A_1}$	$\left(\frac{P}{V}\right)^2\frac{k}{A_2}$	$\left(\frac{P}{V}\right)^2\frac{k}{A_3}$	$\frac{1}{3}\left(\frac{P}{V}\right)^2\frac{k}{A_4}$
Ratio of sectional area per line	$\frac{1}{2}\left(1+\frac{1}{\sqrt{2}}\right)$	1	1	$\frac{1}{3}$
Ratio of total weight of copper,	$\left(1+\frac{1}{\sqrt{2}}\right)+\frac{\sqrt{2}}{2}\left(1+\frac{1}{\sqrt{2}}\right)$			$1+\frac{1}{6}$
i.e.,	=2,91 0.97	4 1·33	3 1	=1·17 0·39

The following explanation may clarify the reference to the 2-phase 3-wire system in the above table :—The current in the common wire is $\sqrt{2}$ times that in each outer, so that for the same current density as in the outers, the sectional area of the common wire is $\sqrt{2}A_1$, and the power dissipated in this wire is $\frac{1}{2}\left(\frac{P}{V}\right)^2\frac{k}{\sqrt{2}A_1}$. Hence for equal total line losses—

$$\frac{1}{2}\left(\frac{P}{V}\right)^2\frac{k}{A_1}\left(1+\frac{1}{\sqrt{2}}\right)=\left(\frac{P}{V}\right)^2\frac{k}{A_2}=\left(\frac{P}{V}\right)^2\frac{k}{A_3}=\frac{1}{3}\left(\frac{P}{V}\right)^2\frac{k}{A_4}$$

$$\therefore A_1 : A_2 : A_3 : A_4 = \frac{1}{2}\left(1+\frac{1}{\sqrt{2}}\right) : 1 : 1 : \frac{1}{3}.$$

Also, in the above table, the fourth wire of system (D) has been assumed half the section of one of the outers, since this neutral wire carries only the out-of-balance current which should be comparatively small if the load is carefully balanced.

The various results can now be summarised :—

Generation :

(A) Generators practically the same.

(B) Switchgear more costly for the 4-wire 2-phase system.

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Transmission :

(A) Equal weights of copper for the 2-phase 4-wire and 3-phase 3-wire with earthed neutrals.

(B) Cost of constructing 2-phase line greater than that of 3-phase line.

(C) The 3-wire 2-phase system is impracticable, owing to its inherent unbalancing effect.

Distribution :

(A) Two-phase 3-wire and 3-phase 3-wire systems are almost equally economical.

(B) For a given minimum voltage, the 3-phase 4-wire system is the most economical in copper.

(To be continued.)

CREDA ELECTRIC BOWL FIRE.

The Bowl Fire produced for the coming season by Credenda Conduits Co., Ltd., Whitehouse Street, Aston, Birmingham, which is particularly noticeable for the efficient manner in which the radiant heat emitted by the element is reflected by the bowl and concentrated upon any desired position, this form of fire should prove distinctly useful in offices, bedrooms, nurseries, bathrooms, etc., where the need arises for local heating.

The bowl of the fire is made from spun copper, which is mounted by means of a swivel hinge on a cast-iron pedestal base, enamelled brown as standard

A substantial wire guard protects the element from accidental contact, and the element has been designed to be easily replaceable. The element itself consists of a spiral wire winding mounted on a fireclay cylindrical support with grooves in which the element rests. The whole element is mounted on a spring support as a safeguard against damage through accidental knocks. It is quite a simple matter either to change the element, complete with the fireclay support, or to fix upon the support a new spiral element. The loading of the element is 600 watts.

With the approach of the new heating season there should be a large demand for this type of fire, and retailers are recommended to apply for full particulars, as it is those contractors and supply authorities that have a stock of fires on hand that secure the best of the demand for heating appliances.



It is during the months of September and October, March and April, or the between season periods as they are often termed, that the greatest demand arises for electrical appliances of this nature, which enable the comfort of local heating to be obtained.

METALLIC RESISTANCE MATERIALS.

NEW B.E.S.A. SPECIFICATION.

Standard Specification No. 115 just issued by the British Engineering Standards Association at 1s. net, 1s. 2d. post free, fixes limits for resistance and dimensions of metallic resistance materials for electrical purposes. A comprehensive list of standard sizes of wires, tapes and sheets is included, and it is to be hoped that wherever possible designers will use these standard sizes. The resistance materials have been divided into five classes :—

(a) For use when a low co-efficient is required at temps. not exceeding 60°C. (such as in standard resistances and in sub-standard instruments).

(b For use when the temps. co-efficient may vary more than that permitted for class A, and at temps. not exceeding 200°C. (such as in instruments other than sub-standard).

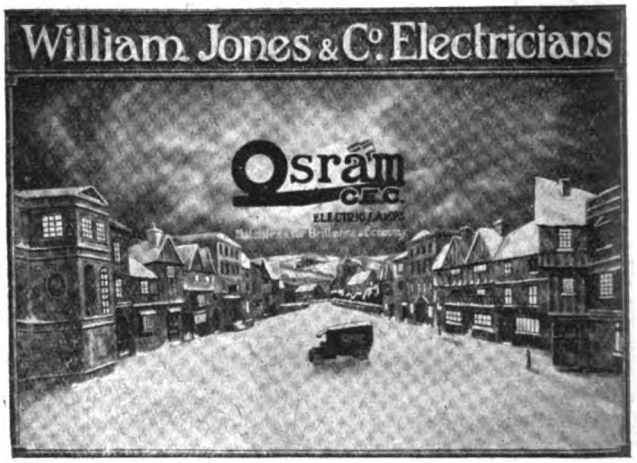
(c) For use when the temp. coefficient may vary over a wide range and at temps. not exceeding 300°C.

(d) For use at high temps. not exceeding 700°C. (such as in heating apparatus).

(e) For use at high temps. not exceeding 1,000°C. (such as in heating apparatus).

AN ATTRACTIVE "OSRAM" WINDOW DISPLAY.

A feature of the G.E.C.'s Autumn Osram Sales Campaign is the attractive window display offered on loan to their clients. This display, and others, are exhibited in the windows at Magnet House, Kingsway, and a brief inspection shows that they combine novelty, good taste, and good publicity value. The illustration shows the Osram display. It consists of a black cloth and various pieces of painted and shaped scenery, depicting a winter scene in an old English village, and is intended to carry home the appeal of the comfort and attractiveness of good lighting. By means of



hidden lamps, the windows in the model houses may be illuminated, thus adding considerably to the realism and attractiveness of the display both by day and by night. The whole apparatus is simply designed and can be erected in a short time.

We understand that a limited number of these displays are available for loan, application for which should be made on the special form attached to leaflet O.S.2619, which also gives full details and instructions for erecting.

These leaflets are being mailed to their trade friends by the General Electric Co., Ltd., and additional copies can be obtained on application to Magnet House, Kingsway, or to any of the Company's provincial branches.

Meetings.—The Junior Inst. of Engineers, will meet on Friday, 4th inst. at 8 p.m. Paper : "Electric Cranes," by C. H. Woodfield, also on Friday 21st inst. at 8 p.m. Lecturette : "Pyrometry for Boilers : some Questions, pertinent and impertinent," by C. E. Foster (Member). Both meetings at Caxton Hall.

New Book.—A new book entitled the "Diagnosing of Troubles in Electrical Machines," has just been published by Messrs. Longmans, Green & Co. The author is Prof. Miles Walker of the Manchester University, and a review of it will appear shortly in the columns of this paper. It is a book which will be of direct interest to every Central Station engineer or man in charge of important electric lighting and power plant, and as such we are sure that it will meet with a ready sale. The price is 33s. net. post free from ELECTRICITY Office.

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Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.

THE ELECTRICAL CONTRACTORS' YEAR BOOK, 1921-1922. (Electrical Contractors' Association. 2s. 6d. net.)—The new edition of this Year Book contains the revised list of members of the Association and its allied corporations as well as a useful history of the undertakings and details of the work which has been carried out by the various committees, together with lists of the other electrical associations with whom the members may come into contact in the course of their usual regular business. There are also details of the arrangements with regard to wages in the different districts throughout England and much other information which will prove of value to the members as well as, incidentally, to any firms who may not yet have joined the Electrical Contractors' Association. It should most certainly be read by every contractor, and, in addition, a copy should be in the possession of every branch secretary of the E.T.U.

THE "ELECTRICIAN" TABLES OF ELECTRICITY UNDERTAKINGS. 1921. 126 pp. (Benn Bros. 10s. net. 10s. 9d. post free.)—In the new issue of these well known Tables a new form of presenting the statistical information has been adopted. The details of the generating and steam raising plant, which were omitted during the period of the war, have now been restored, and as these necessitated more space than could be given in narrow columns, the matter has been reset in a different style. It is believed that the change, which offers greater scope for adding further details as occasion arises, will prove acceptable to all users of the Tables. Several stations made use of oil fuel dusing the coal crisis, and the opportunity has been taken to include some particulars of the oil-burning apparatus employed by a number of undertakings. In regard to the Colonial and Foreign Sections of the Tables, there is still difficulty in obtaining and verifying the data, but so far as possible these have been brought up to date. The publishers are to be congratulated upon the wealth of important information which they have been able to collect. The price of the Tables is very moderate and represents a good investment for those concerned with the information presented.

PRINCIPLES OF RADIO COMMUNICATION. By Morecroft, Pinto and Curry. (Chapman and Hall, 45s. net.)—This volume of over 900 pages may be said to represent the very latest word on the theory and practice of Wireless Telegraphy, as seen from the point of view of an American author holding a high position on the other side of the Atlantic. It is most comprehensive in this respect and takes the reader in succession through the fundamental principles of electrons, electrical fields, and other preliminary ground work, right on to the latest development in spark telegraphy, vacuum tubes, continuous wave telegraphy and radio telephony, as well as dealing with radiation, wave motion and amplifiers; and after a careful perusal, one can but compliment the author on his clearness of expression and the care with which he elaborates his principles. It is profusely illustrated with nearly 800 diagrams which should be of great value to wireless students, and we have no hesitation whatever in recommending it to our readers as a book which is undoubtedly costly, but at the same time represents full value for money.

ARMATURE REPAIRS

MARRYAT & PLACE,
28, HATTON GARDEN,
LONDON, E.C. 1.

PITMAN'S TECHNICAL BOOKS

Just Published.

THE STEAM TURBO-ALTERNATOR.
By L. C. GRANT, A.M.I.E.E.
A Treatise dealing with the various types of turbines, high-speed alternators, and their control gear in present day use for Central Station Engineers and Operators and others. The theory is dealt with sufficiently to enable the reader thoroughly to grasp the principles of the subject without his being confused by the intricacies which must necessarily be studied by those engaged in the design of steam turbo-alternators. With 161 Illustrations. **15s.** net.

THE THEORY OF THE INDUCTION COIL.
By E. TAYLOR-JONES, D.Sc., F.Inst. P.
An exposition of the theory underlying the operation of the modern induction coil. This treatise, which represents much of the author's original work, will be of special interest to the student of high-frequency oscillations and to those engaged in the design of h.f. apparatus. With 93 Illustrations. **12s. 6d.** net.

THE ELEMENTS OF DIRECT-CURRENT ELECTRICAL ENGINEERING.
By H. F. TREWMAN, M.A., and G. E. CONDLIFFE, B.Sc.
This new book is intended to bridge the gap existing between the elementary text-books and the more advanced books dealing chiefly with design. Numerous examples with answers are included together. 146 illustrations. **7/6** net.

THE ELEMENTS OF ILLUMINATING ENGINEERING
By A. P. TROTTER.
An introductory treatment of the units, distribution and measurements of light, types and characteristics of lamps, reflectors, and shades; photometry and the planning of lighting installations. **2/6** net.

ELECTRICAL TRANSMISSION OF ENERGY.
By W. M. THORNTON, O.B.E., D.Sc., M.I.E.E.
A survey of the physical basis of electrical transmission, its methods and phenomena from the standpoint of the electron, for students and engineers. **2/6** net.

BOILER INSPECTION AND MAINTENANCE.
By R. CLAYTON.
A concise treatment of first-class practice in the maintenance, overhaul and inspection of boilers and their accessories. Intended for boiler attendants, mechanics, students and others. **2/6** net.

HIGH-TENSION SWITCHBOARDS.
By H. E. POOLE, B.Sc. (Hons.), A.M.I.E.E.
Deals with high-tension switchgear as assembled in switchboard form for central station and industrial service, enumerating the leading points in design and describing the types of switchboard in most general use. 22 illustrations. **2/6** net.

MANAGEMENT OF ACCUMULATORS.
By SIR DAVID SALOMANS, M.A.
Tenth Edition Revised. A thoroughly revised edition of this well-known indispensable handbook for practical men. 37 illustrations. **7/6** net.

POWER FACTOR CORRECTION.
By A. E. CLAYTON, B.Sc., A.M.I.E.E.
Explains the meaning and importance of power factor, and describes methods for the improvement of power factor. 36 illustrations. **2/6** net.

TESTING OF CONTINUOUS-CURRENT MACHINES.
By C. F. SMITH, D.Sc., M.I.E.E.
Describes the main principles and practice of efficiency and output tests on C.C. Generators, Motors, and Motor Generators. With examples from practice. 21 illustrations and 5 tables. **2/6** net.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclosed stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 126.

What are the essential principles to be observed when designing electro-magnetic relays to ensure quick action? I desire to design a relay with 1-100th second period of contact. This is to operate on 12 volts, being connected to this supply through leads having a resistance of 3 ohms. The circuit closed will carry 15 amperes at 40 volts. I would like details of a suitable design with a method of verifying the accuracy of the relay to operate in the period stated. I would also appreciate the name of a technical book or paper from which I can obtain details of designs of this nature.—"B."

QUESTION No. 127.

I desire to have electric light and electric motors fitted in my boot factory. I would like you to point out the most essential features to be considered when drawing up a specification to enable the correct type of motor and fittings to be installed. The supply is 500 volts, three wire.—"Astatic."

(Replies to Questions Nos. 126 and 127 must be received not later than October 29, 1921.)

Answers to Questions.

REPLIES TO QUESTION No. 123.

No replies of a satisfactory nature were received in connection with this question. This is scarcely to be wondered at when it is considered that the question is not only one of intricate design but must be the result of experiments. Dealing briefly with the points raised it may be said that:—(1) Here an ordinary reverse current relay will meet the case since it is merely a question of calculating the demagnetising effect of one coil against another. Given a certain number of effective ampere turns with normal current, then 15 per cent. demagnetising turns will give the results desired, that is, assuming an efficiency of 100 per cent.

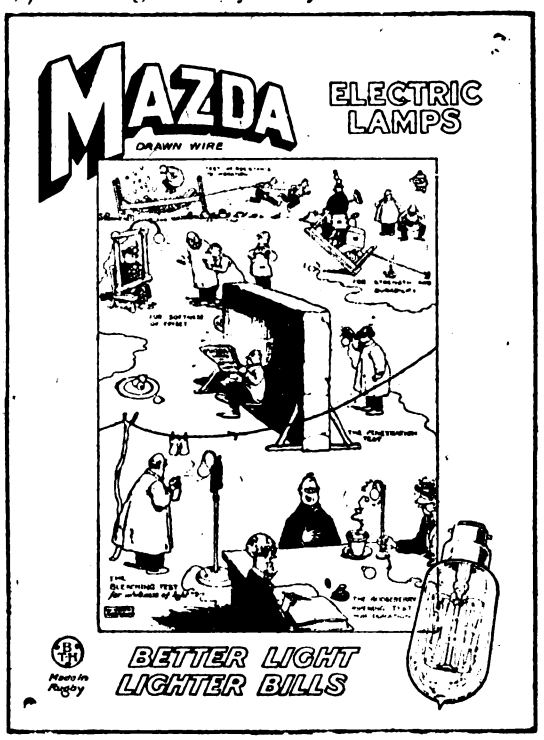
(2) This is the most difficult condition to be considered. Although the normal charging current is not stated, since it is hardly possible that the output of the generator is to be regarded as the normal charging current, the circuit breaker must trip when an overload of 50 per cent. is maintained over a period of ten minutes. This is a very long time and it would be very difficult indeed to design a time-limit relay which would only operate over such a long period. The ordinary dash-pot is entirely out of the question. It would appear that the solution would lie in a rotary electro-mechanical device, such as a meter, which would only commence to operate when a certain value of current is passing through it. With this instrument it would be difficult to avoid "creeping," which would alter the conditions laid down in the question, unless an intricate system of relays were adopted.

(3) This device would, of course, be inserted on the generator side of the motor-generator. The simplest device would, probably, be an ordinary no-load coil holding the breaker over against the tension of a spring. The no-load coil would be energised from the motor supply mains, thus, when the pressure fell to 50 per cent., the spring coming into operation would open the generator circuit.

It would appear that, according to the nature of the question, the above three items are to be included in one protective device. This makes the matter more difficult since it is apparently necessary for the motor and generator mains to be more or less interconnected. Candidly, I do not see why they should be contained in one device. If our querist will draw up his question in the form of a specification and submit it to one of our leading electrical engineering companies as an order to work to, no doubt if they cannot supply one device they will probably supply separate instruments which will meet the requirements set in the question.—Editor ELECTRICITY.

TWO MAZDA SHOWCARDS BY FAMOUS ARTISTS.

Two new season's showcards, lithographed in twelve colours and measuring 15½ in. by 11 in., have recently been issued by the B.T.-H. Co., Ltd., as forming part of the season's Mazda lamp publicity. In one (illustrated herewith) we see Mr. Heath Robinson's whimsical conception of the testing of a Mazda lamp, while in the other, by the well-known artist, Mr. Septimus Scott, humour gives way to symbolism and hilarity to



awed delight. It is headed "Light," and in the hand of the central figure, representing the embodiment of Light, is a Mazda lamp, the light from which bathes the cities of the world at his feet.

Both showcards are, in their different ways, notable examples of art. They are mounted on stiff boards and are provided with cords for hanging. Requests for copies should be addressed to the Advertisement Dept. of the British Thomson-Houston Co., Ltd., 77, Upper Thames Street, E.C.4, or to the company's nearest branch office.

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Various Items.

Bargains.—An advertiser has special bargains to offer in armatures, galvanometers, drills, etc. For details see small advertisements page.

Personal.—We learn that Mr. J. S. Child has resigned his position as joint sales manager to the Edison Swan Electric Co., Ltd., after 30 years' service. For the time being, Mr. Child can be found at his private address, Wormley House, Wormley, Herts.

Bruce Peebles.—Arrangements were made for the members of the Engineering Sect. of the Brit. Assocn., in connection with the recent meeting in Edinburgh, to visit the works of Bruce Peebles & Co., Ltd., where, among the work in progress, the large motor converters for the Brighton, Manchester and Calcutta Corporations were seen on test.

The Western Canadian Markets.—In the current issue of the *B.O.T. Journal*, Mr. L. B. Beale (Trade Commissioner at Winnipeg) deals with the markets of Western Canada. It appears that there should be good business in farm engines and tractors, electric lighting sets, telephone equipment (especially automatic) and electric household appliances.

Accrington.—Arrangements having been made as to a proportionate cost of the expense, a cable is being laid by the Corporation to supply Messrs. Steiner & Co., Ltd., printers' manufacturers, for a night load only. The Town Clerk has been instructed to apply to the Electricity Commissioners for power to borrow the amount necessary for carrying out the work.

Association of Engineers-in-Charge.—On the 12th inst. at St. Brides Inst., E.C.4, Capt. H. Riall Sankey will deliver his presidential address on "Some Recent Advances in Wireless Telegraphy" (illustrations and demonstrations). The twenty-first annual dinner will be held at the Holborn Restaurant to-morrow at 6 p.m. A Ladies' Night (dinner and dance) is arranged for Sat., Nov. 12, also at the Holborn.

Meetings.—The next monthly meeting of the Birmingham and District Electric Club will be held at the Grand Hotel, Colmore Row, on Saturday, October 8, at 7 p.m. Paper: "Commercial Efficiency of the Telephone," by Mr. C. G. Findlay (member). Will all members desirous of joining the snooker handicap please send in their names with remittance of 2s. 6d. on or before the meeting.

Industrial League and Council.—Commencing last Wednesday, this winter's course of lectures on industrial subjects was inaugurated at Caxton Hall by a lecture on the "Capitalistic System," by Mr. E. J. P. Benn. The syllabus shows that the course will be most instructive, and we hope all industrial workers who can will attend as often as possible. The commencing time is 7.30 p.m. and no tickets are necessary. Copies of the syllabus can be obtained from the Gen. Sec., Industrial League and Council (Grosvenor Mansions, 82, Victoria St., S.W. 1).

Electricity in Working-Class Dwellings.—In a valuable report on the use of electricity in working-class dwellings, prepared for the E.D.A. by Messrs. G. Blair, Imrie and T. G. Angell, architects, the Ministry of Health Plan No. 178 (house with scullery, living room, parlour, three bedrooms and bath room) has been adapted for coal, gas and electricity. The complete cost with coal and with electricity comes out the same, and with gas considerably dearer. Four different plans are given. All points, including costs, convenience, hygiene, etc., are carefully considered. It can be obtained from the E.D.A. at the price of 10s. a copy.

Haslingden.—A letter by Major Halstead, chairman of the Electrical Massage Centre, to mayors and chairmen of urban councils, states that the work of the Centre has come to an end, with the exception of ten men awaiting operations and seven still waiting treatment. These have been transferred elsewhere. Since the work was commenced, 1,045 men have passed through the Centre, and practically the whole of them have, by their treatment, been able to resume either their pre-war occupations or some other suitable employment. During the last twelve months 62,462 treatments have been given.

Bournemouth.—The one-day lecture and demonstration, arranged by an energetic contractor, Mr. E. Brontman, of 139, Bournemouth Road, Parkestone, for Wed., the 5th inst., at St. Peter's Hall, is to be prolonged for a further five days. As the demonstration includes cooking by electricity, Mr. Brontman suggested the food so cooked be given to the children of the local unemployed most in need. This idea has been enthusiastically accepted by all concerned, and several prominent ladies and gentlemen are handling the collection and the distribution of the food, being assisted also by the clergy of each parish from which the most needful will be selected. Amongst the committee formed to deal with this matter are the manager of the L.J.C. and M. Bank, Ltd., and his wife, Mr. Seal, the famous architect, and his wife, Mr. Bowman, solicitor, and his wife, and others. Mr. Joe Beckett, the champion boxer, agreed to open the evening proceedings. Was this to keep the gas people away?

Trade Notes.

Reduced prices of "Sunco" electric fires are given in a booklet issued by the **Sun Electrical Co., Ltd.** (118-120, Charing Cross Road, W.C.2).

A new electric soldering iron, the "Wheatcroft," is being made by **Ellis & Coe** (308, King Street, Hammersmith, W.6). The bit is in one piece. It can be taken out to shape the working end to suit the work in hand, and can be easily adjusted for wear. There are two heaters, one above and one below the copper. They can readily be replaced if necessary. The iron is made in two patterns: one has been specially designed for armature work, the hand being protected from falling solder by a fibre guard. The grip is of compressed cork. The bit is 2 in. wide by ⅜ in. thick, and the consumption 400 watts.

Waterwheel Alternators form the subject of a recent illustrated bulletin, designated Circular 1440/1, published by the **Metropolitan-Vickers Electric Co., Ltd.** (Trafford Park, Manchester). This is of particular interest in view of the activity in the development of hydro-electric schemes. The company has been responsible for many installations and the mechanical and electrical excellence of their plant is well-known.

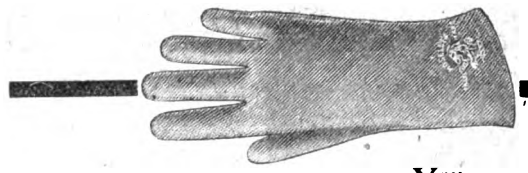
Literature from the **Northern Steel and Hardware Co., Ltd.** (9, South Parade, Deansgate, Manchester), deals with "Strand" portable electric flexible shaft grinders, the "Northern" vacuum cleaner and the "Laundry Queen" (dolly) electric washer and wringer.

The Sun Electrical Co., Ltd. (118-120, Charing Cross Road, W.C.2) are issuing a new introductory pamphlet relating to the A.B.C. Electric Laundress. It contains an appealing picture story, "Just Like a Man."

"Ediswan" semi-indirect fixtures for home and office lighting form the substance of an artistic booklet just issued by the **Edison Swan Electric Co., Ltd.** (Ponders End, Middlesex).

Examples of C.T.S. wiring work in many buildings, covering the complete domestic and industrial field, are given in the form of illustrations in an attractive booklet published by the manufacturers of C.T.S. wires and cables—the **St. Helens Cable and Rubber Co., Ltd.** (Warrington). Besides the illustrations there is a brief letterpress. Readers interested in wiring should not fail to write to the company for a copy of the booklet. We are advised that C.T.S. is being used in the following housing schemes: Ipswich (1,000 houses), Bargoed, S. Wales (999), Weaverham, Ches. (250), Mansfield (160), Walsall (132), Amersham, Bucks (30), Long Eaton (30), Lincoln (12).

A new "Prices Current," or key to the Accessories Catalogue issued by the **B.E. Co. (of London and Birmingham), Ltd.** (Hendon House, 57, Upper Thames Street, E.C.4), has just been published by the company.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
OCTOBER 14, 1921.

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THE ECONOMIC LIMITS OF DISTRIBUTION FROM COAL-FIRED STATIONS.*

By William Bradley Woodhouse.

The economic limit of distribution from a central power station is reached when, as an alternative to further extensions of mains, the establishment of one or more additional stations enables energy to be delivered to the consumers at a lower cost.

The problem is therefore a consideration of the steps to be taken to supply an area which extends beyond the economical limits of the distribution pressure in use.

This is a problem which has presented itself for solution from time to time as the supply of electricity has developed over wider areas. The solutions have been three in number, namely:—

1. To supply from one generating station by increasing the output to meet the demands and adding to the original distribution mains a higher pressure system or systems feeding into the general distribution system at a number of points. The general distribution system may or may not be subdivided into independent sections.
2. To supply from two or more generating stations each feeding a part of the area independently of the others.
3. To supply from two or more generating stations inter-connected by a system of high pressure mains with or without intermediate feeding points.

Within certain limits the first solution is without question the most economical. Starting with a station of, say, 1,000 kw. output, the economies of increasing the size and output of the station are considerable at first, but increase less rapidly as the station becomes larger.

These economies may be summarised under three headings:—

1. *Economy of Capital.*—The total cost of a generating station increases less rapidly than the rated output of the plant installed. This is particularly so in the case of buildings, auxiliary machinery, and steam turbo-alternators.

The reduction of the capital cost of a turbo-alternator is a function of the speed and output. The limiting speed of a 50-cycle turbo-alternator is 3,000 revolutions per minute, at which speed to-day machines of an output of 15,000 kw. may be obtained.

A further increase of output involves a reduction of speed, and mechanical design puts at present an approximate limit of 25,000 kw. to a single cylinder machine, and 50,000 kw. to a two-cylinder machine. It appears, therefore, that economically the limiting size of each turbine unit is some 50,000 kw.

The above remarks apply to the plant installed, but the earning capacity of a station depends on the use which can be made of the plant after providing the spares necessary for security of supply. A brief consideration will show that the proportion of spare plant decreases with the number of machines installed.

A large number of machines for the same total output will cost more; a smaller number, to give the same security, must be of a greater total rated output.

If each turbo-alternator has an overload capacity of 25 per cent., and two sets are regarded as essential spares, then the economical subdivision is into ten sets.

This particular consideration is modified by the relatively high steam consumption of smaller turbines which in a station of, say, 30,000 kw. would reduce the economical number to seven.

Interconnection of stations also affects the question.

A further advantage of a large station is due to the diversity of demand arising from supply over a wide area which may have the effect, as between a station of 100,000 kw. and one of 500,000 kw., of reducing the station demand by some 10 per cent., and the capital expenditure accordingly.

2. *Economy of Coal.*—The increase of efficiency as between turbines of 1,000 kw. and 25,000 kw. under similar steam conditions represents a saving of some 25 per cent. of coal consumption.

The diversity of demand referred to above has its effect in improving load factor and still further reducing the coal consumption. The economies made possible in a large station represent a further saving, but as between a 150,000 kw. station and a 500,000 kw. station the amount is not great.

3. *Economies of Wages and Other Expenses.*—These economies, though marked, represent a saving on only a small part of the total costs, and are relatively less important.

Total Saving.—It is with hesitation that one submits a general figure of the savings to be made on these accounts, it being always possible to quote special and exceptional cases to the contrary. It may be taken, however, that the relative cost per kw.-year varies somewhat as follows:—

	Per Cent.
500,000 kilowatts	100
250,000 ,,	114
150,000 ,,	122
50,000 ,,	173

Cost of Distribution.—Against these economies the extra costs of distribution over the wider area must be set.

The requirements of a constant pressure supply limit the radius of distribution at any particular pressure. If, as is usually the case, the pressure of utilisation and of detail distribution is fixed, then, to supply a wider area, a second system of higher pressure mains becomes necessary, from which the secondary system is applied at a number of points.

This involves capital expenditure on mains, switchgear, transformers and regulating apparatus, on which the annual charges must be met.

The new system of mains and transformers also involves energy losses in iron, copper, and dielectric, and the annual cost of these must be added to the capital charges on distribution.

It should be noted, however, that the addition of the higher pressure system, by permitting the subdivision of the general distributing system, will allow a greater load to be carried on this latter system without further capital expen-

* Abstract of Paper discussed at the Engineering Conference, 1921. (Inst. of Civil Engineers.)

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diture, or alternatively will effect a reduction of energy losses with the same load. In either case this saving must be taken into account.

The total cost of distribution is made up of the charges on capital, the establishment charges, and the cost of energy losses.

With the exception of the copper losses, these annual charges are practically constant, in other words, the economical area of distribution is a function of the load factor of the system.

The economical area is also dependent on the density of load, the uniformity or otherwise of load distribution, the number of consumers, and other conditions which make a comparison between different areas a matter of great difficulty.

If it be assumed that such an area has a density of load of from 500 to 2,000 kw. per square mile, it may be said at once that a pressure of 10,000 volts has been fully demonstrated by practical experience as suitable for general distribution.

The economical area for such a pressure of distribution is approximately 150 square miles from which a station demand of, say 137,500 kw. may be expected to arise.

As an indication of the magnitude of the various charges a comparison may be made for the hypothetical case of an area with a uniformly distributed load.

For the sake of simplicity the area is assumed to be square and the comparison between the three methods of supply indicated above is made for a total area four times as great, or 600 square miles with the stations arranged at the four corners and in the middle.

Comparison of Methods.

Case 1.—Extension of supply to the larger area from the central station involves the introduction of a higher pressure: if underground cables are used a comparison may be made between pressures of 33,000 and 66,000 volts.

The use of overhead lines would lead unquestionably to the use of the higher of these pressures.

As an indication of the costs of these systems, Tables I, II and III have been prepared.

For comparison the annual cost of a kilowatt-year (60 per cent. load factor) at the busbars of a 500,000 kw. station may be taken at £8 with coal at 20s. a ton.

Table I.—Underground Cables at Maximum Ratings.
Cost per K.V.A. Mile.

Pressure.	Cost per Mile.	Rating.	Cost per K.V.A. Mile.
K.V.	£	K.V.A.	£
11	14,000	18,300	0.765
33	18,100	48,600	0.373
66	23,000	78,800	0.292

Table II.—Underground Cables.
Annual Cost of Capital Charges and Energy Losses per K.V.A. Mile.

Pressure.	Rating.	Capital Charges.	Energy Losses.	Total.
K.V.	K.V.A.	£	£	£
11	18,300	0.095	0.085	0.18
33	88,600	0.047	0.028	0.075
66	78,000	0.036	0.017	0.053

Capital charges, 12½ per cent.
Energy losses, 60 per cent. load factor, 0.5d. per unit.

Table III.—Transformers and Switchgear.
Annual Cost per K.V.A. Double Transformation.

Pressure.	Rating.	Annual Cost.		
		Capital.	Energy.	Total.
K.V.	K.V.A.	£	£	£
33	48,600	0.264	0.183	0.447
66	78,800	0.299	0.195	0.494

Capital charges, 12½ per cent.
Energy losses, 60 per cent. load factor, 0.5d. per unit.

Case 2.—The comparison in this case is simple; the subdivision results in the loss of the benefit of diversity, in the increase of the cost of the stations and in a poorer load factor. On the other hand, the expenditure on higher pressure mains and transformers is altogether avoided.

Case 3.—The comparison here made is between equal stations of equal efficiency. Where an existing system is added to, the older stations are likely to be the less efficient, and it will prove economical to deal with the basis load (high load factor) from the new stations and the peak load from the old. Considerable economies of station operation may be gained by interconnection, and for the development of a large area there seems little doubt that whether the stations be of the same class or of different classes (peak and base load stations), practical conditions such as the available condensing water, the distribution of load and the supply of coal, will compel the establishment of more than one station, and that the stations will be interconnected.

The comparative costs are tabulated below.

Comparison of Annual Costs of Alternative Schemes of Supply.

Case	1	2	3
Generating stations:			
Number of stations ..	1	4	4
Total demand kilowatts	500,000	550,000	525,000
Mains and transformers:			
Pressure .. volts	33,000	..	33,000
Route miles	42.4	..	60
Kilowatt miles	5,250,000	..	156,000
Annual costs per kilowatt year:			
At stations	8.00	11	10.2
Distribution	1.23	..	0.24
Total	9.23	11	10.44

It will be seen that for the area considered one large station shows an advantage over four.

If for the same total load the area is increased, and with it the distance between stations, an increase of transmission pressure will become necessary; this will introduce also intermediate feeding points, whose effect on the cost of the 10,000 volt distribution complicates the comparison.

Broadly speaking, however, the comparison on the basis taken shows equality of cost between Cases 1 and 3 when the distance between stations is approximately 30 miles.

Telegraphy in U.S.A.—"Telegraph and Telephone Engineering in the United States" is the title of a paper which was read before the Institution of P.O. Electrical Engineers, by Sir Wm. Noble, Engineer-in-Chief of the G.P.O., on October 11 last year. It has now been reprinted in pamphlet form, price 1s. 9d. net, post free, from "Electricity" office, and can be recommended as a work of direct interest to all who have anything to do with telegraph and telephone engineering. It is well illustrated and contains much valuable descriptive matter.

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ELECTRIFICATION OF RAILWAYS.

FINAL REPORT OF THE ADVISORY COMMITTEE.

The Electrification of Railways Advisory Committee, appointed by the Minister of Transport in March, 1920, to inquire into various questions affecting railway electrification, has recently issued its Final Report (H.M. Stationery Office, 4d. net). The recommendations contained in the Interim Report, issued a year ago, are confirmed and the recommendations may be summarised thus:—

Standard System of Power Generation.—Three-phase at the frequency in general use in the district, or as approved by the Electricity Commissioners (between 25 and 50 cycles). The evidence shows that A.C. "supplied to the sub-stations at a frequency of 50 cycles can be used for railway purposes without any detriment to railway working."

Standard System of Power Distribution.—D.C. at a *Standard Pressure* of 1,500 volts at the sub-station busbars. In special cases a multiple or sub-multiple of 1,500 volts may be used if approved by the Minister.

Standard Collection.—Contact rail and/or overhead contact wire. The *Standard Contact Rail* is to be either top-contact or under-contact rail, with the contact surface in a horizontal plane installed at a gauge of 1 ft. 4 in. from the gauge line of the nearest track rail. Before stating their recommendations (which are given in detail supplemented by dimension diagrams for contact rail and overhead contact wires in the Report), the Committee point out that both types are in use, the top contact being most common for 600/750 volts. In their opinion the under-contact type possesses advantages in regard to interference by the accumulation of ice and snow, and also in regard to the arrangement of protection for men working on the track with the higher voltages. Suitably designed shoes can be run interchangeably with either type.

The *Standard Overhead Contact Wire* is to be installed normally over the centre of the track at a height of 3 ft. above the maximum load gauge likely to be used in the line, and at a maximum height of 20 ft. above the track rail. With regard to the L.B. and S.C. Rly., the Committee find themselves "bound to recognise that if the railway is allowed to electrify its main line to Brighton on its present system, there will, of necessity, have to be a change of locomotives or multiple unit stock in any cases where other companies' trains run over that line, and that to this extent the wished-for general interchangeability will be interfered with. They recognise, on the other hand, that to change the existing suburban equipment of the Brighton Rly. to a D.C. system would involve a large financial expenditure, which the railway itself could not be asked to undertake and which it would be difficult to justify to the public at the present time. It has further been stated to the Committee that the electrification of the main line is in this case very closely connected with that of the suburban lines on account of the necessity, on economical grounds, of using the same rolling stock throughout. Having all these considerations in mind, the Committee recommend as the course which on the whole has the balance of advantages:—(i) That the electrical system of working at present in use, or actually under construction on the suburban lines, need not be changed. (ii) That in view of the recent proposals of the Govt. as to grouping of railway companies, the question of the system on which the L.B. and S.C. Rly. Co.'s proposed extensions to the coast should be carried out is now—in the event of the Govt.'s proposals being approved by Parliament—one for special consideration from the point of view of the requirements of through working and interchangeability of traffic with the other systems forming part of the proposed Southern Group. Subject to these matters receiving the fullest consideration, and provided the completion of the proposed extension on the present system shows a substantial financial advantage, the Committee are of opinion that it should be allowed."

With regard to *Limitation of Drop in Earthed Return Conductors* the Committee recommend, on the evidence and on the practical difficulties attending the imposition of a definite limit, that "(i) It is not desirable that regulations should be issued to limit the drop of potential in an uninsulated return conductor on electrically operated railways. (ii) In cases where it is found impossible to dispense altogether with the present obligations which are imposed upon railway companies by the protective clauses inserted by the B.O.T. and other Authorities into the Acts of the Companies, these obligations should be specified definitely in each particular case."

It is not considered desirable, in the interest of railway electrification, that further regulations (other than those recommended in the Report) be issued for the time being.

A NEW DEVELOPMENT IN ELECTRIC VEHICLE BATTERIES.

The "D.P." Battery Co., Ltd. (Bakewell, Derbyshire), have perfected a type of cell which they claim marks a notable advance in the manufacture of batteries for electric road vehicles, locomotives, etc. It has long been recognised that from the purely electrical standpoint the "flat plate" cell is the ideal arrangement. It enables the best possible use to be made of the available space, which, in the case of vehicle cells, is strictly limited. It ensures, also, that all surfaces of opposite polarity are equi-distant from one another at all points, thus ensuring uniform current distribution, a minimum internal resistance and absence of heating. The great weakness, however, of the flat Faure type plate has been its short life due to the softening and disintegration of the positive active material, and its deposition as peroxide mud in the bottom of the cell. No effective method has hitherto been devised for retaining it. In any case once it has become soft, and lost its coherent structure, little purpose is served by holding it in the grid by purely mechanical means. Peroxide of lead reduced to the condition of mud has little capacity, owing to its loss of conductivity. This serious defect of the ordinary flat Faure type plate has no doubt largely assisted to check the more rapid development of battery traction. The Faure type plate is in all other respects so eminently suitable for this class of work that any manufacturing development which will make possible its successful application to electric vehicle and similar work is a big step in the right direction. The "D.P." Co. claim that they have succeeded in producing this result. The process employed in the formation of the positive active material gives it an exceedingly hard crystalline structure, which resists the softening effects of high temperature and heavy rates of charge and discharge. In conjunction with these positives a special form of separator is used, known as the "D.P. Patent Combined Separator." This separator is porous, elastic under compression, and unaffected by sulphuric acid or electrolytic action. It possesses also the property of a filter upon which its value as a separator largely depends. It function in the cell is four-fold.

(1) By its filter-like action it prevents grains of peroxide from leaving the surface of the positive plate, while at the same time it permits the free diffusion of acid and the escape of gas. It thereby prevents the gradual erosion of the surface of the positive active material due to the evolution of gas during charge. Thus, by protecting the surface layers of peroxide, it keeps the underlying material intact. No deposit is thrown down in "D.P." vehicle cells, so that they never require to be cleaned out.

(2) Being under slight compression between the plates it tends to expand the sections fanwise, thus ensuring a good tight fit in the container. This is important as it prevents vibration on rough roads or bad surfaces. "D.P." cells will, therefore, stand rough work without fracture of the plates or cracking of the containers.

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(3) Being proof against the destructive effect of nascent oxygen and sulphuric acid, it remains intact and makes short circuits impossible.

(4) In the event of a cracked or broken container, the porous separator sheets retain sufficient moisture to prevent damage to the elements from exposure to air and the consequent heating of the negative active material.

Needless to say, the above are very valuable features, which have been amply demonstrated.

In a new catalogue the "D.P." Co. give prices, sizes and full particulars of these batteries and include five pages of valuable information concerning installation and working.

OSGLIM

ELECTRIC LAMPS.

Under patents Nos. 13759/14, 155783, 135485, 135486, 136175 and 138642, jointly owned by the B.T.-H. Co., Ltd., and the G.E.C., Ltd., low c.p. Neon gas-discharge lamps, known as Osglim, are now being commercially manufactured in this country. They consume 5 watts as a maximum, and are available for use on circuits between 200 and 250 volts A.C. or D.C.

An entirely new principle in lamp making is involved in the design, which consists essentially of two metal electrodes sealed into a glass bulb containing rarified Neon gas. These electrodes are connected to the circuit by a bayonet cap and B.C. holder in the ordinary manner. The potential difference between anode and cathode produces an electrical discharge across the rarified gas, and as a result of the ionic bombardment, a glow of a characteristic reddish orange colour is produced as a luminous haze surrounding the cathode. The construction of the lamp is simple and the absence of filament does away with the weakest part of an electric lamp. The mechanical strength is therefore very great, being limited only by the strength of the glass bulb.

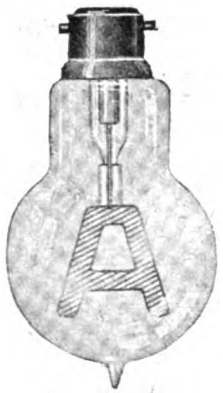


FIG. 1.

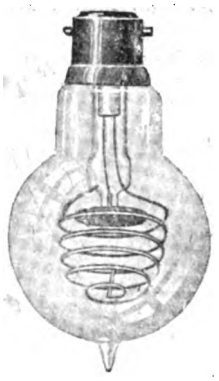


FIG. 2.

At present two distinct patterns are made: The "letter" type (Fig. 1) has the cathode made in the form of a block letter, numeral, or single device about 1⅜ in. high. This is principally used in simple signs for displaying a word or words, which, by the way, are nearly as conspicuous in daylight as in the dark. The other type (Fig. 2), for use where merely an indicator or safety light is required, has the cathode made of a thick wire spiral wound roughly into the shape of a beehive. The glow is produced on D.C., when the cathode only shows the glow, or on A.C., when both electrodes are luminous. Some modifications are introduced into the D.C. lighting lamps, however, which make them less effective on A.C., so that in practice two separate types of this pattern lamp are made. The letter lamps are made suitable for use on either A.C. or D.C.

The possibilities of the Osglim lamp are almost unlimited. Many uses to which they may be put will be obvious to all who have come in contact with lighting problems, and other uses will doubtless be discovered as occasion arises. The lighting lamps are primarily intended for dim illumination. They make excellent night-lights for nurseries, sickrooms and hospitals, and may be used for all night illumination of corridors in hotels, ships, etc. For domestic illumination they have been used with good effect in bracket fittings, not, of course, as the main source of illumination, but to add a touch of colour to the lighting scheme.

On account of its low current consumption and distinctive light, Osglim lamps are highly satisfactory and economical as pilot lights, circuit indicators on switchboards and for other similar duties.

For illuminated advertising, the Osglim letter lamp has a wide field of application, not only on account of the nature of its design but also on account of the novel and distinctive quality of its light and the extremely small current which it consumes. Permanent illuminated notices such as "Exit," "Showroom," etc., can be provided and maintained at very small expense, and by means of a suitable range of letters an infinite number of illuminated announcements can be obtained economically and with a minimum of trouble. The General Electric Co., Ltd., have designed an attractive range of signs for use with these lamps. A universal adjusting device is fitted to each lampholder so that individual lamps may be turned, raised or lowered to bring them into correct alignment. (Several examples could be seen at the Engineering Exhibition at Olympia.) It may be mentioned here that the company's illuminating engineering department will willingly help to develop customers' own ideas, and give them advice as to the use of Osglim lamps.

Copies of a new leaflet (Os. 2569) and full particulars of Osglim lamps and signs can be obtained on application to Magnet House, Kingsway, or to any of the G.E.C. provincial branches.

A NEAT ADAPTOR.

The accompanying illustration shows a neat lampholder-adaptor made by J. J. Eastick and Sons, of Chromolyte Works, 3, Belfast Road, Stoke Newington station, N.16. It is made of polished brass (or else finished in nickel), the white china portion being highly glazed. The plugs project at an angle, so that the adaptor can be used without removing the shade or reflector. For full particulars interested readers should write to Messrs. Eastick, asking for list "A."



Answers to Correspondents.

H. BRIGHT (Crawleyside, Durham).—(1) Yes. (2) No. (3) The rise and fall of current in the secondary is the same as that in the primary. (4) An induction motor, as the name implies, depends upon induction for its operation. Alternating current is supplied to the stator and, due to the rise and fall in the value of the current, an alternating current of the same frequency is induced into the rotor, when at rest. The field set up is rotary and this causes rotation of the rotor, the currents being of lower frequency as the speed rises. From this it will be seen that it is merely transformer action which is taking place, since the rotor is not connected to the A.C. supply.

Faraday House Journal.—The Michaelmas term issue has now been published and as usual is full of the doings of "Old Faradians," various notes, etc. Dr. Alex. Russell (the Principal of Faraday House) contributes an article on the Capacity between Spherical Conductors.

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Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

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All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Train Lighting.

During the war there was deplorable wastage of valuable lives in the defence of Liberty. Now that Peace reigns once more, there is absolutely no excuse for neglecting any precautions which will avoid the wilful waste of equally valuable lives which can never be recovered. The "Safety First" slogan is being well advertised in connection with street and railway traffic dangers, and the general body of the public are in consequence being gradually, but surely, educated to use discretion in their wanderings about our busy cities and towns. With regard to railway dangers, and especially avoidable risks, there is surely none with which we have had greater and more disastrous experience than that accruing from the prevailing system of lighting trains by compressed gas, carried in easily deranged containers under the coaches. These potential bombs are the first items to suffer in a collision or disaster of any kind, and the almost invariable result is that the liberated gas immediately catches fire and adds to the total death roll.

During the past few years, casualty after casualty has been reported as directly due to this grave risk. On every occasion the Press of the country has preached the gospel of reform in train lighting, yet there are still a considerable number of British railway coaches lighted on this system, and the avoidable risk remains just as great to-day as when attention was first drawn to it. Only last week a disaster occurred on a suburban railway section in France, and the only deaths were proved to be due to fire caused by the escaping gas from the wrecked coaches. It is simply criminal, in the circumstances, that railway authorities should be permitted by law to continue working trains thus equipped. We all recognise the difficulties in the shape of time and cost imposed by such a wholesale conversion to electric lighting as is implied, but it is not as if the railway people had not had due time to effect a cure.

Years have passed by since the first disaster of this kind, and the lesson it conveyed. I have a friend who went through the Ditton Junction disaster some years back, and just escaped death from this cause, and ever since his experience I never enter a railway carriage without glancing at the system in vogue. If there are electrically lit coaches on the train I always select them in preference, and quite apart from the superior illumination afforded where electricity is installed. Expense should not be considered in this connection; human life is far more precious than mere dividends, and the sooner the railway companies waken to a sense of their serious responsibilities in this matter, the better for the railway travelling public.

Electrical Relief Schemes.

The prevailing unemployment problem is prompting the authorities, as well as the interested public, to look around for some labour absorbing tasks which will also prove profitable to their promoters and the ratepayers in each district, and not mere work-creating schemes with no justifiable object in view. Among the many jobs calling for urgent execution in the public interest, such as road conditioning, building, etc., that of extending electricity supply mains to some of the outlying districts not yet served with a supply of current would appear to provide relief in many quarters. Thus, a recent letter in a Liverpool paper drew attention to the fact that a number of the Corporation houses, although occupied and fitted and wired for electric light, had no supply, owing to the absence of mains. Another correspondent appealed on behalf of local shopkeepers in outlying districts who still await their long-promised juice, and for the same reason. There are a number of wiremen and electrical workers unemployed in that city, and this would appear an excellent opportunity to absorb some of them.

Another correspondent, writing in the *Daily Mail*, suggests the extension of the privileges of electrical service for domestic requirements to those smaller householders less able to incur the initial expense of the various electrical appliances by supplying these appliances such as vacuum cleaners, heating and cooking devices, sewing-machine and knife-cleaning motors, etc., on hire-purchase terms. Quite a good suggestion, and one which should commend itself to enterprising municipalities. Another suggestion, emanating from Glasgow, is that the prime cost of wiring and connecting a house service, as well as the interior wiring and fitting, be imposed in the form of instalments, which the average small householder would be better able to negotiate than the existing system of paying for the whole job at the outset. This also is a suggestion worthy of notice, and should tend to extend the use of electricity if adopted.

The £200 Electromobile.

The possibilities of the independent electric passenger vehicle or runabout have been sadly neglected in this country, and even the application of this principle to commercial work is only now being developed on anything like commercial lines. Yet there is an enormous field for compact electric vehicles of the kind referred to if only some enterprising manufacturer would take his courage in both hands and produce such a car on quantity lines, designed for all-round town and suburban service, and to sell as cheaply as possible on standardised lines. A Chicago resident, writing in the *Daily Express*, comments on our neglect of this promising means of transport, and states that in that city such electric runabouts are quite common, the weight of the neces-

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sary accumulators having been decreased by 50 per cent. and the capacity similarly increased, so that it only remains to develop ample charging facilities in every populous area, and the field is ready for exploitation.

An electric is peculiarly simple in construction, easy to drive and control, creates no nuisance, is comparatively noiseless when running, and is subject to far less expenditure in running costs and upkeep than the corresponding petrol vehicle. It has its limitations, of course, in regard to speed and radius of operation, but such a car as I have outlined could well replace the thousands of petrol cars which are at present used mainly by business and professional men for short radius town work with frequent starting and stopping. I enjoyed a short run in just such a vehicle over twenty years ago through the streets of Reading, and even in those early days was impressed with its possibilities. Then the battery problem was still very real, but to-day marvellous progress has been made in the lightening and strengthening of electric vehicle batteries. Moreover, nothing suits a storage battery better than constant hard work, such as is involved in the class of duty referred to. It is standing idle or being subject only to intermittent and variable discharges which so rapidly depreciates the best battery yet turned out.

The Talking Film.

A combination of gramophone, phonograph or telephone record with the modern cinema film has long been a dream of inventors, and numerous attempts have already been made to successfully combine the two modern principles, thus rendering possible the reproduction of a stage play with speaking characters. The advent of the thermionic valve has brought the problem a shade nearer solution, but there are great difficulties in the way still, and it would appear doubtful whether a really natural effect can ever be secured. The success of spoken dialogue depends principally upon the natural intonation and inflection of the voices of the actors and actresses, and no producing device yet invented has succeeded in exactly imitating these human traits. Nothing must be regarded as impossible in these highly scientific days, however, and it may be that some unknown genius is already on the eve of success in this connection.

ELEKTRON.

THE B.T.-H. COMPANY AT OLYMPIA.

A particularly attractive and well arranged stand (Fig. 1) at the recent Olympia Exhibition was that of the British Thomson-Houston Co., Ltd. Reference to the wide scope of the exhibits has already been made, including the special type of Mazda lamp—the "Navy Bulb" lamp—supplied for marine service.

The subject of ship lighting was treated in a decidedly novel and artistic manner. The back of the stand was divided into three panels. These panels were occupied by painted canvases depicting respectively the promenade deck, the dining saloon and the lounge of a modern liner. The panels were painted by a scenic artist, and had a most realistic appearance from the front of the stand. Appropriate electric light fittings equipped with lighted lamps were painted into the pictures, while in front, and so fixed as to appear part of the pictures, were metal and lacquered embodiments of the painted fittings, these actual fittings being, of course, in use. An example of one of the panels is shown in Fig 2.



FIG. 1.



FIG. 2.

A corner window of the stand was occupied by the Mazda Window Display, a most attractive conglomeration of revolving shades, showcards, a plaster model and other accessories.

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NEW BELLING HEATING AND COOKING APPLIANCES.

In the new season's 48-page catalogue of fires, cookers, water heating appliances, etc., issued by Belling and Co. (Derby Road Works, Montague Road, Upper Edmonton, N.18), is to be found information concerning electric heating and cooking of interest and value both to contractors and clients.

New designs of fire-bars are introduced, and new designs of fires make their appearance. The original and well-proved bar is, however, wisely retained, as are several of the neat well-designed fires which have achieved thorough success in the past.

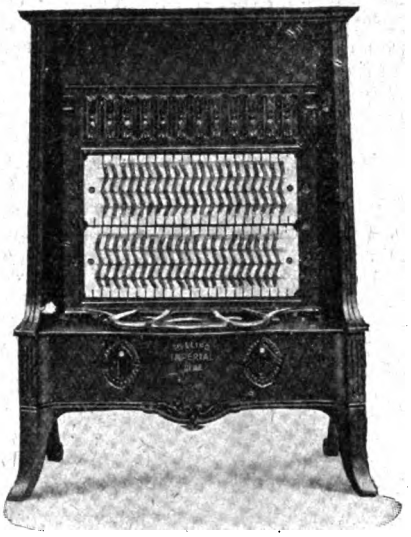


FIG. 1.—"IMPERIAL" FIRE.

The "standard white bar," it will be remembered, is loaded to 500 watts, while in the "standard brown bar," which is made of light brown fireclay instead of white porcelain, the loading is increased to 666 watts. It is of the same dimensions as the "white bar," for which it can be substituted by those desiring a more concentrated form of heat. In the new "Verti-wave bar" the loading is further increased to 1,000 watts. The heating spirals are "waved" vertically, and in use give a most pleasing effect. This bar is fitted to new designs of fires known as the "Imperial" (see Fig. 1) and "Wavewell."

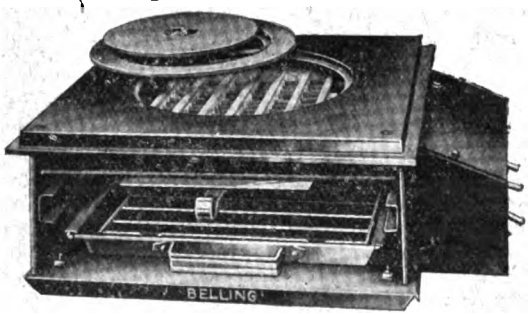


FIG. 2.—BOILER-GRILLER.

Another new bar of 1,000 watts loading is the "Multi-parabola bar." This is designed convex when viewed from the front, the face consisting of a number of wells of parabola shape, in which the wire is arranged in correct focus. As a result the heat is well distributed in the room. All the bars are 10¾ in. long, with 10 in. fixing centres. The first two are 1¾ in. wide and the latter two 3 in. wide. Among the new designs of cooking appliances reference must be made to the "Boiler-Griller" (Fig. 2), which is loaded to 1,200 watts and has three heats. The top plate is of cast-iron, removable rings being fitted. The sides and base are of steel, finished black. The element is so designed that liquids spilt on it do not affect it. To connect the "boiler-griller" into a "cookerette" a detachable oven (11½ in. wide by 11 in. deep by 15 in. high) can be added. At the top of the oven is a similar element, also loaded to 1,200 watts. In use the cast iron rings from the "boiler-griller" are removed and put in the hole provided in the top of the oven, if desired. When the oven is in use the lower side of the bottom element can be used for other purposes, or the heat deflector plate inserted to send all the heat up into the oven. Similarly, saucepans, etc., can be heated from the upper-side of the top element. The device is of ingenious construction.

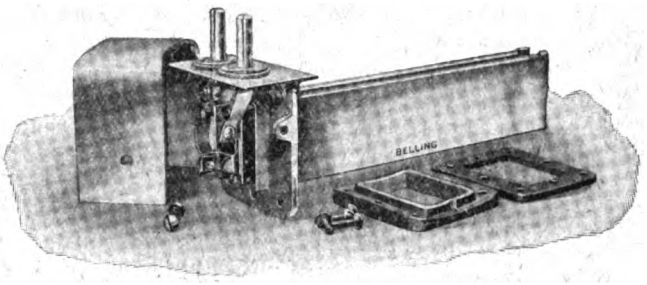


FIG. 3.—IMMERSION HEATER FOR QUICK BOILING KETTLE.

Considerable attention has been given to the general problem of water heating, and we believe that the Belling immersion heater, for fixing into existing hot-water tanks, finds extensive application. Fig 3 shows the immersion heater used in the Belling quick boiling kettle. It can obviously be used for converting existing ordinary kettles, urns, etc., to electric. The blades are of the construction previously described in our pages. The flange for attaching the heater to the kettle is curved to suit the general size of kettle—about 8 in. diameter. The flange is soldered to the kettle and the heater then screwed to the flange, with steam-tight packing between. Thus the heater is bound to take a correct vertical position. It is supplied complete with the "M.K." connector, which, together with "M.K." wall plugs and sockets, a new combined switch plug and the "M.K" fire switch ("Footpress" pattern), as fitted to many Belling fires are listed separately in the catalogue.

TELEGRAPHY.—GRADE I. (1921).

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in April, 1921.

(*Continued from page* 545.)

Q. 5.—What are the essential qualities of iron and steel for electromagnets and permanent magnets? On what does the strength of an electromagnet depend? How would you wind the coils of a telegraph instrument for use on long lines, and why?

A. 5.—The cores of electromagnets should be of high permeability and very low retentivity. Soft iron carefully annealed possesses these qualities in a high degree, being easily magnetised inductively and quickly losing its magnetism when the inducing force is removed. Permanent magnets should have great retentivity; so that although difficult to magnetise

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they retain the magnetic property permanently. Hard steel highly tempered meets this requirement.

For a given quality of iron and size of core, the strength of an electromagnet is directly proportional to the number of ampere turns, the latter being the product of the number of amperes traversing the magnetising coil and the number of complete turns of wire on the core. Hence an electromagnet of 4,000 turns traversed by a current of 25 milliamperes would have the same strength as an electromagnet of 2,500 turns traversed by a current of 40 milliamperes because the ampere-turns, viz., 100, is the same for both.

The coils of a telegraph instrument for use on long lines should be wound with many turns of fine wire. The reason for this is that a long line has high resistance and the received current very small, so that many turns of wire are necessary to obtain the required magnetic effect. The wire must necessarily be thin, otherwise the electromagnet would be excessively bulky; the extra resistance added, however, does not materially decrease the current owing to high resistance of the line in comparison.

Q. 6.—What materials are used for aerial line insulators and what are the relative properties of such materials? Sketch and describe an insulator and spindle. For what purpose is the rubber or felt washer used?

A. 6.—The most commonly employed materials used for insulators in this country are porcelain and earthenware. Glazed porcelain is used mainly on account of its high insulating properties, and brown earthenware on account of its cheapness.

In America and in other countries having dry climates, glass insulators are largely used. They are cheap and their transparency does not favour the formation of cocoons and spider's webs beneath the cups. The hygroscopic nature of glass and its fragility prevents its use in England.

A sketch of the Cordeaux double-shed porcelain insulator, half in section, and spindle is shown in Fig. 3.

It is cast with a hollow screw thread in the neck to receive the screw of the spindle. The spindle is provided with a shoulder, on which rests a rubber washer, and the insulator is screwed down on the washer and the spindle. This arrangement lessens mechanical vibration and decreases the liability of the insulator to fracture due to sudden stresses or to the effect of the differing rates of expansion, due to temperature changes, of the metal spindle and the porcelain.

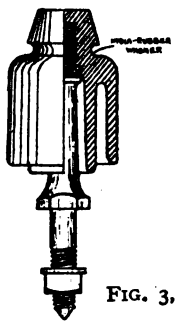


FIG. 3.

The principal mechanical features of the insulator are:

(1) that the spindle passing through the neck takes much of the stress which would otherwise fall on the insulator;

(2) the porcelain cup has great tensile and compressive strength;

(3) porcelain does not deteriorate.

The principal electrical features are:

(1) porcelain has a high specific resistance;

(2) the distance between the wire and the bolt is great; and

(3) the inner cup remains dry during wet weather and so lessens the tendency of the current to leak over its surface.

(To be continued.)

THE WILLANS DIESEL OIL ENGINE.

The Willans Diesel Engine as made at the Rugby works of the English Electric Co., Ltd., since 1905, is of the vertical single-acting reciprocating type, designed to produce power from inexpensive fuel of the crude oil class. The essential points of difference from the ordinary types of gas or oil engine are:—(1) The fuel is sprayed into the cylinders during part of the working stroke, and combustion occurs gradually without explosion, as the atomised fuel enters. (2) Ignition is brought about solely by the temperature attained by the air in the cylinder at the end of the compression stroke, and there is therefore no ignition apparatus of any kind. (3) There is no explosive mixture present in the cylinder prior to the working stroke. (4) No carburettor or vaporiser of any kind is required. (5) The fuel used is crude petroleum residue, or other similar oil having a high flash-point.

The engine works on the well-known 4-stroke cycle, the sequence of operations being as follows:—The first down stroke draws in air only. The following up stroke compresses the air and causes its temperature to rise sufficiently to ignite the fuel when it is sprayed in. During the first period of the second down stroke fuel oil is blown into the cylinder in a finely-divided spray and combustion occurs followed by expansion of the hot gases after the fuel is cut off. The following up stroke is the exhaust stroke during which the products of combustion are expelled to the atmosphere.

The quantity of fuel required per b.h.p. per hour for a Willans Diesel Engine even of small size is only about .45 lb. at full load, .55 lb. at half load and .75 lb. at quarter load, while for engines of larger size the fuel consumption is still lower. The high economy on light loads is an important advantage of considerable value in many industrial plants. Standard sizes range from 100 b.h.p. at 250 r.p.m. to 500 b.h.p. at 200 r.p.m. at altitudes up to 500 ft. above sea level. For each additional 1,000 ft. 4 per cent. of the output must be deducted.

In a test carried out on a combined 100 b.h.p. 250 r.p.m. set supplied to the order of H.M. War Office, the following fuel consumptions were actually obtained:—

Load.	Lb. per kw. per hour.
Full	0.69
¾	0.713
½	0.817
¼	1.22

The fuel used was crude oil, calorific value 18,000 B.Th.U. per lb.

As regards cooling water, assuming that it enters the engine at 60°F. and leaves it at 120°F., the quantity required will usually be not greater than 4 to 5 gallons per b.h.p. per hour. This cooling water may either be taken from the usual water supply or a cooling tower of very small size may be used.

The general arrangement of the Diesel plant is as follows:—

A main fuel reservoir of sufficient capacity for 24 hours' running is fixed at a suitable height for supplying a fuel filter tank by gravity; the fuel filter tank combines the functions of an oil filter and float chamber for maintaining the standard head of oil above the fuel pump. The oil flows to the pump by gravity. A reservoir to hold a supply of ordinary paraffin for occasional fuel pulveriser cleaning purposes is provided. For fuel storage, an old boiler shell may be used with advantage, fixed in any

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convenient position, and fitted with a small hand pump and piping for filling the reservoir. For starting up an air compressor driven directly from the crankshaft to supply air at a pressure of about 1,000 lb. per square in. to the injection air reservoir and two starting air reservoirs is provided. These three reservoirs are supplied already charged when the engine is installed, but subsequently they are kept charged by the air compressor, one of the two starting reservoirs being held in reserve. During running, the air for blowing the fuel into the cylinder is supplied by the air compressor delivery through the injection air reservoir. The engine is first turned by hand to the starting position, the starting valve lever put into its working position, and the air supply from the reservoirs turned on. After the engine has made a few revolutions, the starting valve lever is thrown out of action, the fuel valve thus being brought automatically into operation so that the engine continues to run until the fuel supply is cut off.

The fuel is then forced into the fuel valve in such quantities as the load on the engine demands, by means of the fuel pump, the admission of fuel to the cylinder being controlled by a needle valve in the fuel valve chamber, actuated by a lever driven from the engine camshaft. When the needle valve opens, the fuel is blown violently past the pulveriser and enters the cylinder as a fine mist at a pressure of about 450 lb. per square inch.

The products of combustion are released by means of a mushroom valve and a fresh supply of air is admitted by means of the inlet valve. Both of these valves are actuated from the camshaft. A centrifugal governor controls the inlet valve of the fuel pump and thus regulates the fuel supply to the engine, so that the amount of fuel forced into the cylinder depends upon the load at the moment before ignition, and the strength of the impulse is exactly proportional to this load. This method of governing, together with the uniformity of the ignition, gives extremely even running. The crankshaft bearings are lubricated by revolving oil rings, while the crank pins are supplied by gravity feed. The lubrication of the piston and piston rings is by forced feed, positively timed.

WIRING FOR SURFACE WORK.

In the catalogue of the Ediswan house wiring system, to which detailed reference has been made in these columns, some notes are given on suitable connections to meet most of the cases that arise in ordinary wiring work. As these diagrams are of some interest we reproduce them. Fig. 1 shows the ordinary looping connections with single cable,

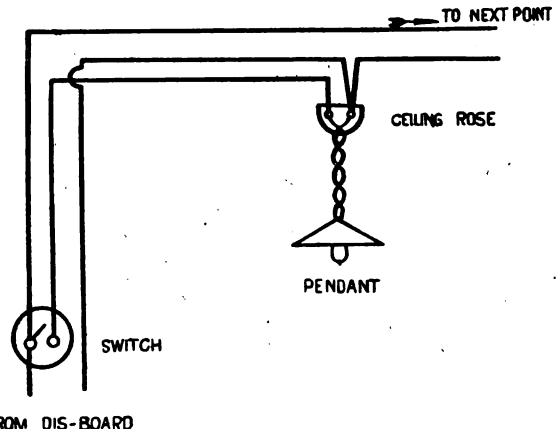


FIG. 1.

or twin and single cable employed on conduit work. This method necessitates the use of the bonding ring at all switches and ceiling roses except the last in circuit, and is not necessarily the most economical in material and labour in the case of surface wiring with metal-covered cable. In Fig. 2 the connections are shown for looping-in with twin cable only, using junction boxes. (A junction box for each switch connection is required, but no bonding rings at switch or ceiling rose blocks, unless more than one point is on the same switch, are necessary.) These connections, with occasional slight modifications, will be found the most economical to use in a large number of buildings, and also simplify the subsequent wiring of additional points.

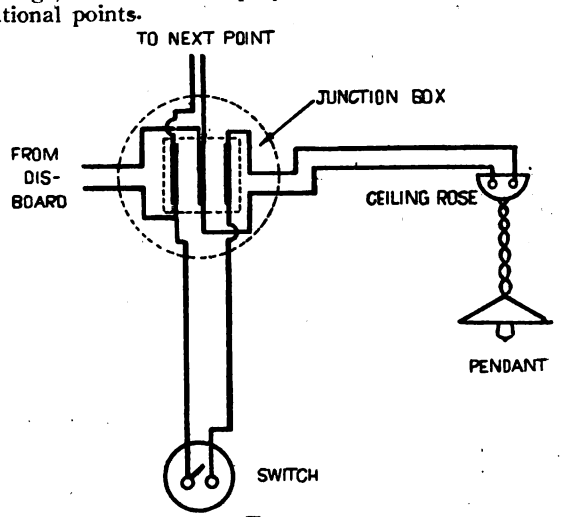


FIG. 2.

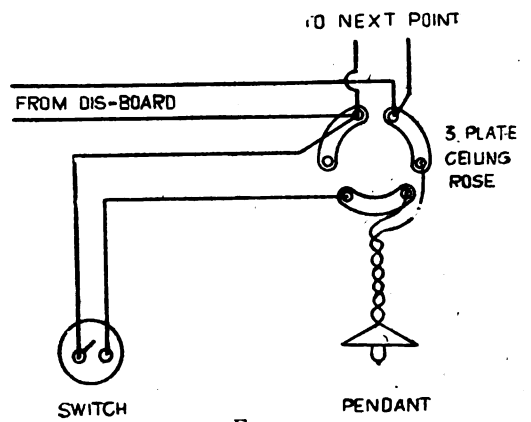


FIG. 3.

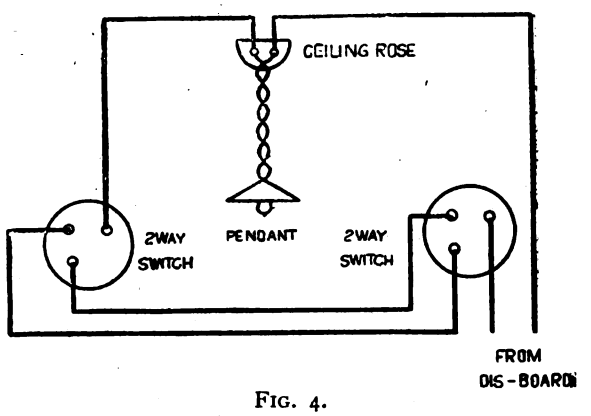


FIG. 4.

Fig. 3 shows a particularly neat arrangement if the switch is near the lamp—it will be noted that looping connections using twin cable only, and a 3-plate ceiling rose are employed, a bonding ring at each ceiling rose but not at the switch being necessary. It will generally be found that the connection in Fig. 2 will work out the simpler when the feed and loop to the next point are nearer to the

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switch, and in Fig. 3, when they are nearer to the ceiling rose. If, however, the wires are run under the floors to ceiling rose points, it will mostly be found convenient to follow Fig. 2, placing the junction boxes under the floor immediately above the ceiling roses.

In Fig. 4 are given the connections for controlling a lamp from two switches in different positions, as for staircases, etc. Single, or twin and single cable is used and bonding rings are required at all points.

IMPROVED LINK TYPE DISCONNECTING OR JOINT BOXES.

The disconnecting boxes now being manufactured by the Nuneaton Electrical Contracting Co., Ltd. (Nuneaton), are of the well-known diving bell pattern, but the lids for all types are circular (see Fig. 1). Double glands are provided for each cable, and are equally suitable for use with either single, multicore or concentric cables. They may be provided with two wood

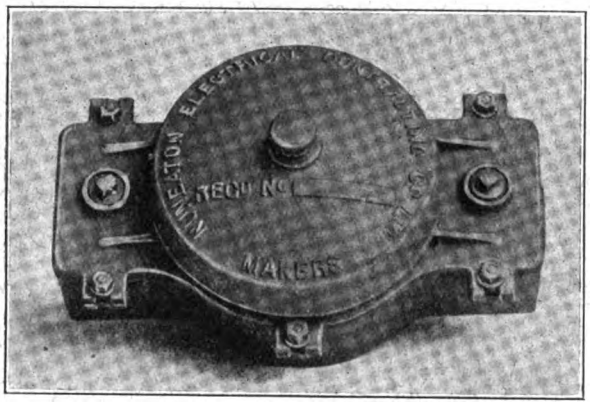


FIG. 1.—ONE-WAY JOINT DISCONNECTING BOX.

bushes for bitumen-sheathed cable, lead armour clamps for lead-covered cable, or with plumbing sleeves in cases where it is desired to plumb the lead. They can also be fitted with single or double wire armour clamps as used in colliery work, and the larger types of two, three and four-way boxes can be provided with separate glanding where three or four cables enter one way of the box. "Siluminite" is used instead of wood for the

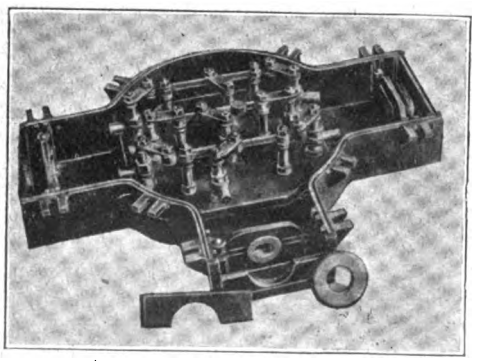


FIG. 2.—INTERNAL FITTINGS.

base boards, which are kept from the base by black, hard-vulcanised fibre insulators (instead of porcelain insulators). With regard to the fittings (Fig. 2), the design is such that the base C (Fig. 3) is not disturbed by the jointer, consequently the alignment of the links is not affected. There is no danger of foreign matter becoming lodged, or air pockets forming, in the cavities into which the nuts fit in the "Siluminite" base-board D, as the holes are filled up with a hard compound. The fitting A can be easily tightened up by means of a box spanner, and the sweating thimble B is machined simultaneously on both faces by milling cutters, thus ensuring the true parallel surfaces necessary for perfect contact. Moreover, with the same end in view the

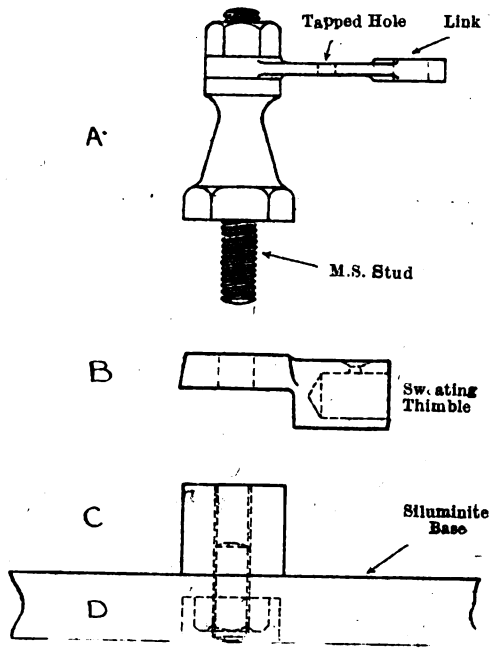


FIG. 3.—ORDINARY DUTY PATTERN LINK AND FITTING.

face of the base C and the base of the fitting A are also carefully machined to fine limits. The component parts A and B, as well as the links, are made of an alloy containing from 96 to 97 per cent. pure copper. Fig. 3 shows the "ordinary duty" link and fitting. The heavy duty pattern is made on similar lines, but all studs are of mild steel and a washer is cast on the hexagonal brass nut. Ease of access and manipulation are marked features and are readily apparent.

THE JUNIOR INSTITUTION OF ENGINEERS.

A local section of this institution was successfully inaugurated at Loughborough, Leicestershire, on Wednesday, October 5. The president, the Right Hon. the Lord Weir of Eastwood, P.C., took the chair at the inaugural meeting held at Loughborough Town Hall, the chairman of the Institution, Mr. B. E. Dunbar Kilburn, M.A., and other officers from headquarters being present. There was a large attendance of engineers of all ages. The resolution that the section be established was put by the chairman and carried unanimously. Lord Weir then inducted Mr. H. Schofield, M.B.E. (Principal of Loughborough Technical College), as its first chairman.

The new section will have its headquarters at the College, a meeting room and equipment having generously been provided by the Governors, and persons resident in the district desiring further information should apply to the local hon. secretary, Mr. G. Mavor, the College, Loughborough, Leicester.

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THE COMMERCIAL EFFICIENCY OF THE TELEPHONE.

A lecture on this subject was given on Saturday last, at the Birmingham and District Electric Club, by Mr. G. C. Findlay (member), who commenced his paper with a short reference to the historic development of telephony, and then gave an exceedingly lucid and, so far as time allowed, a very detailed description of the technical equipment of the modern telephone exchange, giving some account of the many devices at present being developed to increase the load capacity of cables.

The lecturer agreed that the automatic exchange was in process of successful development, but he feared economic reasons would delay universal adoption.

The paper further dealt with the administrative side of the development, and, in passing, pointed out that the war had depleted the staff to such an extent as to make recovery to normal a slow process.

The lecturer concluded by pointing out that the commercial efficiency of the telephone depended to quite an unrealised extent upon the subscriber and his staff.

The lecture was fully illustrated by lantern slides, and was closely followed by an appreciative audience.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 126.

What are the essential principles to be observed when designing electro-magnetic relays to ensure quick action? I desire to design a relay with 1-100th second period of contact. This is to operate on 12 volts, being connected to this supply through leads having a resistance of 3 ohms. The circuit closed will carry 15 amperes at 40 volts. I would like details of a suitable design with a method of verifying the accuracy of the relay to operate in the period stated. I would also appreciate the name of a technical book or paper from which I can obtain details of designs of this nature.—"B."

QUESTION No. 127.

I desire to have electric light and electric motors fitted in my boot factory. I would like you to point out the most essential features to be considered when drawing up a specification to enable the correct type of motor and fittings to be installed. The supply is 500 volts, three wire.—"Astatic."

(Replies to Questions Nos. 126 and 127 must be received not later than October 29, 1921.)

ALL ABOUT MAGNETIC BRAKES.

BY H. S. B. ROBINSON.

Although only slight reference has been made in a previous article to tramway brake gear, which is undoubtedly the most important part of a car equipment, it will be seen from the following remarks that without a complete knowledge of the various braking effects, the car and its occupants are liable to be placed in jeopardy.

Ordinary Stops:—When a car has been brought to a stop by the magnetic brake, the hand brake should always be applied to hold it at rest, but both brakes should never be applied at the same time. When applying the magnetic brake for ordinary stops, care must be taken to avoid jerking, and it is also equally important that the controller handle is never moved more than one notch at a time. By making a short pause on each notch, it will be seen that smooth, quick stops can readily be made. In making ordinary stops, this pause should be longer than in cases of emergency.

Emergency Stops:—On a fast-running car, the brake will be effective when the controller handle has been moved over to the first braking notch, but with a car at low speed, the handle may have to be moved to the second, third or fourth braking notch before the required braking effect is obtained. It will be an easy matter to move the controller handle to the proper braking notch for making emergency or service stops and for slowing down, by observing the different braking effects at various speeds.

Slowing Down:—When, for any cause, the magnetic brake is applied for slowing downfrom high speed but not for stopping the car, the controller handle should be moved from notch to notch as in ordinary stops until the speed is reduced to some six miles per hour, before moving it back to the off position.

Coasting Gradients:—When descending hills with the magnetic brake, the car must be brought to rest at the commencement of the descent, which can be done by setting the controller handle immediately over to the last braking notch and allowing it to remain in that position until the car has gained sufficient speed to put the brake in operation. It will be seen that the speed will then be practically constant while the controller handle remains on this braking notch.

Condition of Track:—On slippery rails, the brake should be applied a little more gradually by allowing a slightly longer stopping distance than when the rails are in good condition. It is hardly necessary to mention that sand is required for the magnetic brake, the same as for the hand brake.

Backward Braking:—For braking a car running backward, the operations required are obviously exactly the same as for a car running forward, excepting that the reversing lever of the controller must be set to the backward position. It may happen that when ascending an incline there is danger of a car running backward owing, perhaps, to the trolley current being cut off from the car or from some other cause, in which case it will be necessary to throw the controller handle over to the off position, and the reversing lever to the backward position, after which the controller handle should be immediately moved to the last braking notch with one movement. If this is done in time it will be found that the car is prevented from running backward. Should the car have been allowed by mistake to gain any speed backward, the brake must be applied notch by notch until the car has been stopped.

JOHN E. RAWORTH & MOSS,

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Various Items.

Trafford Park Estates Ltd.—A dividend of 8 per cent. for the past year has been declared.

Blackburn.—The Electricity Committee propose to erect an electricity sub-station at Mill Hill.

Press Congress of the World.—On the 17th inst. a "Press Congress of the World" opens at Honolulu. It is to be hoped that the Congress will be of genuine service to journalism, and through journalism to the world. We extend our good wishes.

Commercial Motor Exhibition.—At this exhibition, which opens at Olympia to-day, and will remain open till Saturday the 22nd inst. (daily 11 a.m. to 8 p.m., admission 2s., except Saturdays when the price will be 1s.) the latest developments in all classes of commercial vehicles, steam, petrol and electric, as well as accessories, may be inspected.

St. Annes.—The Council have confirmed a resolution that application be made to the Commissioners for a loan of £9,740 for supplying electricity to Lytham, made up as follows:—Supplying and laying cables £6,460; disconnecting pillars and section boxes £390; services, including cable, etc., £1,250; meters (100) £320; and footpath £1,320.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 14th inst., at 8 p.m. Paper: "Electric Cranes," by C. H. Woodfield, M.I.Mech.E. (member). Slides. Also on Friday, 21st inst., at 8 p.m. Lecturette: "Pyrometry for Boilers: Some Questions Pertinent and Impertinent," by C. E. Foster (member). And on Friday, 28th inst., at 8 p.m. Lecturette: "Water Gas Manufacture," by F. Colin Sutton (member) Slides. All at Caxton Hall.

Personal.—Messrs. Johnson & Phillips, Ltd., Charlton, S.E.7, have appointed Mr. W. A. Booth as Assistant Engineer at their City Office, 12, Union Court, Old Broad Street, E.C.2. Mr. Booth was for several years Assistant Engineer at the works, in their switchgear, transformer and junction box depts., and will specialise in these branches in connection with his new duties, on which he has already entered.

London County Hall.—The L.C.C. having accepted the tender of the Pirelli General Cable Works, Ltd., at £2723 17s. 1d., for main and circuit cables, have given the firm a further order, value £3,100. Additional main lighting switchboards are on order from Messrs. Dorman & Smith, and Messrs. Gillett & Johnston have secured the contract for the installation of synchronised clocks at £2,566 4s.

Society of Technical Engineers.—The September issue of the "Journal" is devoted to a careful statement of the policy being adopted by this Society. Although the Society will not associate itself with the Labour Movement, it will, nevertheless, most earnestly seek to find some means of co-operation with Unions of Manual Workers connected with the industry, in pursuit of the second group of its objects, namely: those concerned with efforts to secure the advancement of the Engineering Industry of the British Empire. The headquarters address of the Society is 102, Belgrave Road, S.W.1.

Reduction in Wages.—In accordance with the National Wages Agreements entered into by the Nat. Federated Elec. Assocn., and the E.T.U., the sub-committees have agreed that the variation in cost of living justifies a 10 per cent. variation in wages, from the end of the first pay period in Oct., exclusive, to the end of the first pay period in Feb., inclusive. For this period the wages are to be: Grade "A," 2s. 3d. per hour; "B," 2s. 0½d.; "C," 1s. 10½d.; "D," 1s. 8½d. Wages are adjusted every four months, the variation being 1 per cent. for each 3 points variation in the B.O.T. cost of living figure ("all items") from 150 per cent. above July 1914 (taking the average of the figures published on or about the 18th of the month in which the Committee sits and of the three preceding months).

T. I. G. B.—The Technological Institute of Great Britain have, we understand, instituted, in addition to their existing postal course on electrical engineering, special postal courses for training students for the A.M.I.E.E. examination and the City and Guilds examinations in telegraphy and telephony. This is the only Correspondence Institute we know of that gives its students a written guarantee to the effect that all homework will be examined solely by Corporate Members of the Inst.E.E. Furthermore, included in this course is a valuable series of text books which have been specially chosen and adapted by the T. I. G. B. for the A.M.I.E.E. exam. These books are presented to the student and become his own property. They need not be returned. They also publish a very interesting Free Book about their system of postal tuition, which is worth getting. Their address is 11a, Thanet House, 231-232, Strand, London.

Belfast.—At the monthly meeting of the Corporation last week, by a majority it was decided to dismiss the consultants, Messrs. Preece, Cardew and Rider. The result of that was the Electricity Committee resigned in a body, this "giving the Council the opportunity of appointing a committee that would more effectively carry on the work." Sir Joseph Davidson said that the time had come when the critics of the committee should arise and do the work themselves. Several other matters were before the Council, a motion to increase the price of current by 20 per cent., another asking consent for an application to the Commissioners for a loan of £550,000 for the completion of the new power station, and a third for sanction to pay £707 15s. 3d. fees to the consultants. The increase in the price of current was passed and the other two motions referred back to committee. Since then a movement to upset the decision of the Corporation relative to the consultants—which was carried by a majority of two only—has been set afoot, and a special meeting of the Council has been requisitioned. Sir James Johnston is to move the recision of the resolution. Councillor T. E. Alexander is to move the formation of a new Electricity Committee. (This meeting has since been held and the resolution rescinded by 23 votes to 19).

Trade Notes.

The Osram "Huntalite" candle-type lamp, which is a very good imitation of a white wax candle, is described and priced in leaflet OS. 2520 just issued by **G.E.C.** Being made in one piece, it is rigid and will remain upright even in piano sconces, where vibration is unavoidable, without the use of clips or other devices. It can be fitted to any existing fitting without alteration of wiring, and is, of course, particularly suited to various "period" fixtures.

In their new season's heating and cooking 48-page catalogue, **Belling & Co.** (Derby Road Works, Montague Road, Upper Edmonton, N.18) state that they have a well-equipped tool shop and first-class high power presses. They are, therefore, able to quote for any type of press tool, or for any kind of stamping in bulk, also for embossing dies and die sinking.

Once again have we enjoyed the Monthly Magazine of **Higgs Bros.** (Sand Pits, Birmingham). Not only were we pleased to read the jokes and study the humorous illustrations, but also to note the reduced prices of Higgs motors, and the re-arrangement of the stock list, which now covers A.C. and D.C. motors, with dynamos of various voltages.

"Magnet" Fires of 2,000 and 4,000 kw. loading, in heavy ornamental cast-iron, are illustrated and priced in folder No. H2604 recently issued by the **G.E.C.**, from which firm may also be obtained leaflet No. H2607 giving revised catalogue prices of their full range of electric cooking and heating appliances.

Our thanks are due to the **Metropolitan-Vickers Electrical Co., Ltd.** (Trafford Park, Manchester), who have sent us their latest "Cosmos" Calendar for 1921-2, on which is reproduced in 11 colours their new poster advertising "Cosmos" lamps. Each retailer of "Cosmos" lamps is being supplied with a copy on application, together with a showcard which embodies the same design, and also, when required, with supplies of the Company's latest envelope enclosure 4102/6 giving prices, overprinted with the retailer's own name and address. Attractive advertising of this nature is in the general interest of the retailer, the supply, authority, and the manufacturer, and we trust that the Company will be amply rewarded.

Full particulars of the patented "Safuse" and "Donlok" H. O. Switch and Fuse Gear, which is guaranteed to comply with the most stringent requirements of the Home Office for the use of electricity in non-textile and non-fiery mines, are given in a new reprint of the 40-page catalogue, issued by the manufacturers, **Donovan & Co.** (47, Cornwall Street, Birmingham).

The Reliance Engraving Co. (1904), **Ltd.** (Waldeck Road, Chiswick), are manufacturers of chemically, machine and hand engraved cast, enamelled, pressed and printed name plates, etc. Also advertising novelties.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
OCTOBER 21, 1921.

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TELEVISION.

By MARCUS J. MARTIN.

To do for the eye what the telephone has done for the ear is a problem that has fired the imagination of many inventors during the last half-century, but up to the present all attempts have been more or less failures. It is, however, an alluring and fascinating problem, the invention of some means whereby the actual presentment of a person or subject placed at the transmitter can be produced instantaneously and automatically at a distance, and although "television" is possible experimentally, it is at present, from a commercial point of view, impracticable.

Previous to the discovery of selenium (a non-metallic element possessing a high degree of electrical resistance, variable with the amount of light to which it is exposed) all attempts made to solve the problem of television failed. Although several spasmodic efforts were made to transmit to a distance by electrical means writing, and even sketches, the experiments were soon abandoned, there being at that time no incentive for development, principally owing to lack of possible application. With the discovery of the electrical properties of selenium the early workers saw the possibilities of application to the solution of the problem of television, and numerous suggestions were put forward for this purpose.

As was only to be expected, the earliest workers endeavoured to construct their apparatus to work upon a principle somewhat similar in character to that of the human eye, but in this case, as indeed in many others, the mechanical imitation of one of Nature's marvels, remarkable for its great simplicity, proved to be an exceedingly difficult problem, and one that up to the present still awaits a really practical solution.

The arrangement and action of the earliest apparatus devised for television was somewhat as follows: At the transmitter was arranged a screen which was divided into a large number of small square compartments, each compartment containing a selenium cell. At the receiving station was a similarly divided screen, each compartment in this case containing a small electric globe. One wire from each cell was connected to a common battery terminal, the other battery terminal being connected to earth, while at the receiver one wire from each globe was also earthed. The remaining terminals on each selenium cell and globe were separately connected by means of a length of line in such a manner that each selenium cell at the transmitter was connected to the globe that occupied a similar position on the receiver.

When the surface of this selenium cell mosaic is influenced by the shadow of a simple black and white image projected upon it, those cells which are illuminated will have their resistance lowered, allowing sufficient current to flow through the various line wires and light the lamps to which they are connected at the receiver, while those cells which remain unexposed, and which form the image at the transmitter, will have their corresponding globes in darkness.

In this manner a fairly good representation of a simple black and white image can be obtained, but the limitations of the method are obvious. Not only is it restricted to working over extremely short distances, but to transmit any subject with reasonable accuracy would necessitate the use of a very large number of selenium cells and globes. To transmit and receive a picture measuring 2 ins. by 2 ins. with a grain as fine as that of an ordinary newspaper illustration, would require at least 40,000 selenium cells and globes and a similar number of connecting lines, and the apparatus to transmit such a picture over a distance of 100 miles would cost at least one-and-a-quarter million pounds, besides which, the manufacture of such a large number of similar selenium cells would be commercially impossible. Numerous modifications of this method have, however, from time to time been patented, under such titles as the "Televue," and "Telephot," but no attempt has ever been made to work the ideas up into practical form, owing principally, no doubt, to the enormous expense involved.

Several experimenters have endeavoured to construct apparatus in which one or more rapidly moving selenium cells could be made to take the place of the large number of stationary cells as first suggested, but from the beginning two serious difficulties presented themselves: (1) obtaining complete synchronism between the instruments at the transmitting and receiving stations, and (2) overcoming the slowness of the selenium in responding to the very rapid changes in the illumination that were necessary. The whole process of building up the secondary picture being required to take place in less than one-tenth of a second, which is the time that a visual impression is retained upon the retina of the eye—television on these lines being based upon that defect of the eye commonly known as the persistence of vision.

The question of synchronism, however, forms by far the most important problem requiring solution. In ordinary high-speed telegraphy the methods of synchronism employed have to be very nearly perfect in order to transmit and receive clearly only a few thousand signals per minute, and as in television anything from 10,000 to 100,000 signals *per second* would have to be transmitted, and each signal received and arranged in its correct position on the receiving screen, it is evident that the solution of this difficulty will be no easy matter.

In a new method of television recently worked out by Mr. A. A. Campbell Swinton, and described by him in *Nature*, the sluggishness of the selenium and the almost insurmountable difficulties of accurate synchronism have been partially overcome, but even this method could only be made to work over a very short length of line in which the capacity effects were very slight and can in no way be looked upon as a practical solution to the problem, although it undoubtedly opens up a large and as yet unexplored avenue of investigation.

As every telegraph engineer knows, inherent line properties would totally prevent the transmission of anything like the enormous number of signals required for television, and this fact alone proves that television, at least as far as transmission over metallic conductors is concerned, cannot be considered. Wireless methods, however, remain, and although the wireless transmission and reception of such a large number of signals might be accomplished, there would still be the question of synchronism.

As already pointed out, to obtain accurate synchronism between two rapidly revolving bodies as regards both speed and position, even where the two instruments are electrically connected, is an exceedingly difficult problem, but where they are required to run independently as in wireless television, the difficulties are increased a hundred-fold.

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SOLVING THE INDUSTRIAL PROBLEM.

Although the Mansion House meeting on October 13 did not carry us very much farther in the direction of doing something really practical to solve the present trade depression and the consequent unemployment; it did serve to keep the matter in front of those in whose hands the solving of this problem lies, namely, industrial and labour leaders. The following resolution, proposed by Mr. G. H. Roberts, M.P., seconded by Viscount Burnham, was passed by a large majority:—

"That this Mansion House meeting of the Industrial League and Council reiterates its considered policy that prosperity to this country can only be achieved as a result of closer and friendlier relations between employers and employed. It views with satisfaction the action of the Prime Minister in calling together to the counsels of the nation representatives of employers, labour, commerce and finance to explore all possible avenues towards a solution of the present industrial trouble, and urges the Government to use every means available to relieve the present situation, by encouraging and fostering all possible means to reduce the cost of living, to lower the cost and increase the measure of production, and, by international arrangements, to stabilise the rate of exchange, and that special consideration be given to the claims of agricultural development both in the United Kingdom and throughout the Empire, in the interests of the nation as a whole."

The meeting, which was termed a conference, was, in fact, confined to the mere moving and supporting of the resolution by the speakers already referred to. Their remarks, however, were to the point, and, seeing that they represented both sides, it was interesting to find how completely they were in agreement one with the other. Whilst urging the necessity for the stabilisation of the exchanges in developing our foreign trade, each speaker also contended that a great deal had to be done at home by the employers and employees themselves. Too much must not be expected from the Govt., which had its limitations, and the inconsistency of first asking the Govt. to take its dead hand off industry, and then demanding that it should interfere again with a view to putting things right, was pointed to. The Govt., said Mr. Roberts, had been blamed for not foreseeing the present grave state of affairs in the industrial world, but he himself was of the opinion that no one could have foreseen it. If Labour had foreseen it, then they had acted criminally since the Armistice in wasting the amount of money they had in incessant strikes; Labour had, since the Armistice, pursued a wrong policy.

Coming from a Labour leader, this expression of opinion is welcome to those who really study the industrial question, and gives good reason for hoping that it will be tackled in a more practical manner than has been the case hitherto.

Viscount Burnham, after expressing the hope that a conference would be held between this country and America to consider the financial circumstances of the world and how best to deal with them, pointed to the danger of the doctrine preached from platforms throughout the country, of the suppression of capitalism. This, he said, was a deterrent to enterprise, a threat to those who could, after all, invest their money elsewhere, and was in itself a cause of unemployment. The present drastic wage cuts were really necessary, and employers were not out to reduce wages to the lowest possible penny; it would be mere folly on the part of any set of employers to provoke disturbance in their own trade in order to obtain one or two per cent. more interest, when the difficulty was to get any at all. In fact, many would be paying income tax out of capital this year.

Mr. H. E. Blain and Mr. G. N. Barnes also urged the necessity for co-operation between employers and employed, as the only way to improve present conditions.

BRITISH EMPIRE EXHIBITION.

The British Empire Exhibition, of which H.M. the King is patron, and H.R.H. the Prince of Wales President of the General Committee, will be held at Wembley Park in the summer of 1923. It is being organised with the approval of H.M. Govt., who have obtained the authority of Parliament to contribute the sum of £100,000 towards the Guarantee Fund, and has the support of the Prime Ministers of the Overseas Dominions and of the representatives of the Indian Govt., who have promised their cordial co-operation in ensuring its success. While the Exhibition will only be open to the public for six months during the summer of 1923, the buildings which it is proposed to erect at Wembley Park will become the permanent home of a number of important trade exhibitions, and the principal athletic grounds in the country As a result of arrangements which have been made with the approval of the B.O.T., the British Industries Fair will in future be held at Wembley Park, and the Sports Ground, which is designed to accommodate 125,000 people, will become the permanent home of the Football Association, who have taken it on a long lease and will hold there the final of the Association Cup Tie. Similar agreements have been concluded with a number of important associations, and others are now under negotiation.

Up to October 1st of this year, guarantees, chiefly from London firms, to a total of approximately £450,000 (including the Govt. guarantee) have been secured, and at the request of H.R.H. the Prince of Wales, meetings are being called in the leading provincial centres with a view to the formation of local committees to assist in the completion of the fund. It is earnestly to be desired that full financial support will immediately be forthcoming. Communications should be addressed to the General Manager (U. F. Wintour, Esq., C.B., C.M.G.), British Empire Exhibition (1923), Inc., 16, Hobart Place, London, S.W.1.

The objects of the Exhibition are (*a*) To find fresh sources of national wealth in the development and utilisation of the raw materials of the Empire; (*b*) To foster inter-Imperial trade, and find fresh world-markets for Dominion and Home products; (*c*) To make the different parts and peoples of the British Empire better known to each other, and to focus public attention in this country on the illimitable possibilities of India and the great Dominions overseas, as well as of the Crown Colonies and Dependencies—"our vast undeveloped estate."

G.E.C. HEATING AND COOKING SALES CAMPAIGN.

In order to stimulate the demand for their "Magnet" heating and cooking appliances, the General Electric Co., Ltd., have inaugurated a vigorous campaign in which they invite the co-operation of their trade customers. Although extensive general advertising is included, the main effort will be expended in intensive publicity, in order to drive home to the public the many advantages of the "All-electric" house. To this end the company is prepared to confer with individual dealers and to help them to organise and conduct heating and cooking campaigns suited, in each case, to the particular conditions obtaining in their own districts. We understand that one of the features in the campaign will be a series of exhibitions which will be organised and held on the premises of the various dealers, the G.E.C. loaning suitable apparatus and trained demonstrators in addition to providing suitable publicity and advertising matter.

A special window display, featuring "Magnet" apparatus is also available. It has been attractively designed to point out the cleanliness and convenience of electrical heating and cooking appliances as compared with older methods, a brazier, sooty kitchen range, etc., being displayed on the

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background; whilst in front are marshalled their electrical equivalents. Each article is linked by coloured ribbons to a central easel, which announces in bold lettering the advantages of the "Magnet" (electrical) way. The key to the whole idea is contained in a large representation of a switch bearing the slogan, "Just switch on, that's all!"

Dealers are invited to make early application to Magnet House, Kingsway, W.C.2, or to any of the Co.'s provincial branches.

A FOOT-CANDLE METER.

Illumination cannot be judged by the eye, but a simple, convenient and scientifically accurate means of measurement is afforded by the Foot-Candle Meter shown in Fig. 1. There is a graduated scale at the top, a volt-meter (bottom left) and a rheostat switch (bottom right). The locking-pin in the switch handle prevents the lamp from being accidentally switched on and also prevents the instrument from being put in the case when the switch is on. The case of oxidised sheet steel is fitted with a leather grip at top, and a leather case with sling strap completes the outfit. The total weight with case is 4 lb., and the outside dimensions of the instrument are 7⅞ in. by 6 in. by 1½ in. The screen (Fig. 2) forms one side of the light box and consists of a piece of clear glass on which are two thicknesses of paper. One sheet is fairly opaque and is pierced with round holes and the other is translucent. The electric lamp is fitted with a small reflector

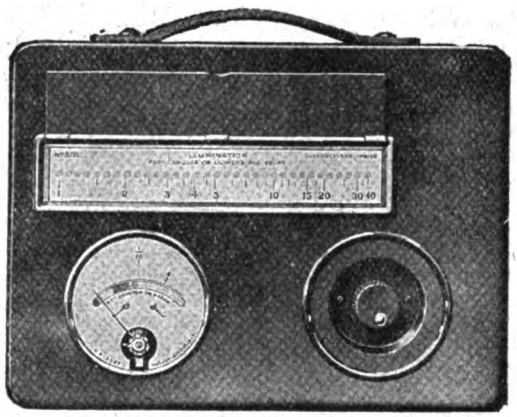


FIG. 1.

and is at the right-hand end of the light box. Since this end of the screen is more intensely illuminated than the other, the holes to the right will appear brighter than the screen, and those to the left darker. The outside illumination is, of course, uniform over the whole surface of the screen. From this it is evident that the round hole at that point on the screen where the internal illumination is equal to the external illumination which is being measured will match its surroundings. Fig. 3 shows the back of the case opened, with a section of the light box cut away to show the lamp and a part of the reverse side



FIG. 2.

of the screen. The dry battery supplying current to the lamp runs the whole length of the case above the light box. The battery should be changed when difficulty is experienced in setting the voltmeter pointer to the arrow mark. Any battery of the same size and type may be used as a replacement. The rheostat consists of a resistance in series with the switch, and by turning the switch handle until the voltmeter pointer is over the arrow mark on the dial, the resistance is so adjusted as to ensure correct voltage at the lamp.

To use the instrument the meter is placed on the table, bench, counter, or wherever the illumination measurement is to be taken. After raising the hinged cover of the screen, the locking pin in the switch handle is lifted, and the handle turned to the right until the pointer of the dial on the left comes to rest at the arrow. A look at the screen will then enable the user to determine easily which of the



FIG. 3.

round spots matches the background. The figure at the selected round spot gives the foot candles. As the Foot-Candle Meter shows exactly the illumination at any part, it enables the ordinary man to diagnose his lighting, and say definitely whether more or less is needed. If the trouble is simply insufficiency, it may often be corrected by using larger lamps. Sometimes the intensity is too great in some places and too low in others. In such cases, it may be necessary to change lamps, reflectors or spacing, or all three.

Further information on this matter may be obtained from the Illuminating Engineer's Department of the British Thomson-Houston Co., Ltd., 77, Upper Thames Street, E.C.4.

THE "UTILITY" CURRENT LIMITER.

A new current limiter of the flicker type, made by Electrical Utilities, Ltd. (1-3, Shelgate Road, Battersea Rise, S.W.11), has recently been put on the market. It consists of a vertical tube of insulating material sealed at each end with a metal cap, and having an electrical contact piece inserted in its side (see diagram). The tube is filled with mercury to the level of the contact piece, and has floating in it a suitably shaped iron core which is attracted by a series coil placed round the upper portion of the tube. The main current of the circuit to be controlled passes from one terminal through the coil to the contact piece on the side of the tube, then through the mercury to the lower metal cap, and from thence to the other terminal. When the current passing round the coil exceeds a predetermined value the iron core is sucked up, causing the mercury level to drop and breaking the circuit. As soon as the circuit is thus interrupted the core falls again and re-establishes the circuit, and a pumping action is set up which continues until the lamps constituting the overload are switched off. The limiter will flicker with the addition of a 20-watt lamp to the normal load, and will immediately stop flickering when this 20-watt lamp is removed.

A condenser is connected across the "break" to eliminate sparking, and the limiter operates for an indefinite period on "flicker" current without damage. The tube is screwed on the outside, and is fixed to the coil support by means

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of two lock nuts. This method of fixing enables the position of the iron core, with respect to the coil, to be adjusted, thus forming a simple and effective means of extremely accurate calibration. The range of adjustment provided is 2 to 1.

The interior is completely enclosed in an iron, case, and suitable arrangements are made for sealing, to prevent interference by unauthorised persons. It can also be arranged with terminals hidden from view, the external leads passing through a bushed hole in the base (B, Fig 1). The

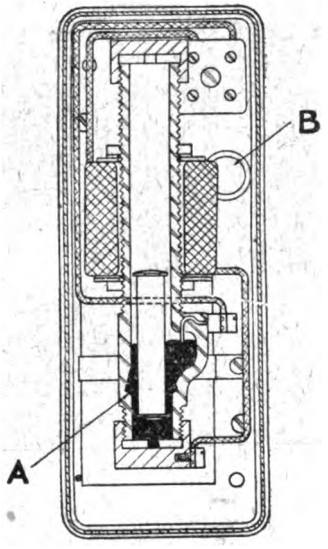


FIG. 1.

standard limiter provides for a flickering current when the predetermined current is exceeded by any amount. Under these conditions a certain amount of heat will be generated if heating appliances are connected in the circuit, but excessive energy will not be obtainable unless the consumer attempts to use apparatus having twice the capacity of the limiter. If it is considered necessary a patented "cut-off" device, consisting of an internal groove cut in the tube (A, Fig 1) can be provided. This device does not come into operation with a small overload of say 10 or 20 per cent.; with a heavy overload, say 70 to 100 per cent., the increased pull on the core causes it to rise higher in the tube in its pumping action, and the bottom flange slips into the groove and is retained there until the *overload is removed* and two or three taps are given to the case. The resetting is simple and can be done by the consumer.

Some of the advantages claimed are:—

Permanence of calibration, absence of deleterious sparking, simple design and robust construction, absence of moving mechanism or contacts, simple and accurate method of adjustment, extreme sensitiveness to overload and steadiness when overload is removed.

The instrument can be put into service without adjustment or filling up, as the movable core and the mercury are contained in an hermetically sealed tube. It can be relied upon to operate on "flicker" current for an indefinite period without damage; it is not affected by dust, dirt or dampness, and is suitable for use in any climate.

Another Electrically-Propelled Ship.—There has just been completed at Belfast, by Workman, Clark and Co., Ltd., for the United Fruit Co., Ltd., of Boston, U.S.A., an electrically-propelled ship, the *San Benito*. The gross tonnage is 3,724, and the dimensions 340 ft. by 46 ft. by 31 ft. 9 in. The only particulars at present available are that three oil-fired single ended boilers, fitted with superheaters, feed a B.T.-H. Curtis turbo-alternator set, which supplies a 3-phase synchronous motor, coupled, as is usual, direct to the propeller shaft. The ship is specially constructed for the banana trade, but accommodation for first-class passengers is provided.

SWITCHES AND CIRCUIT BREAKERS.

The following British Standard Specifications have recently been published:—

No. 109/21. Air-Break Knife Switches and Laminated Brush Switches for Pressures not exceeding 660 volts.

No. 110/21. Air-Break Circuit Breakers for Pressures not exceeding 660 volts.

The specifications (Rentell, 1s. 2d. each, post free) form part of a series which are at present under consideration by the B.E.S. Assocn. During their preparation it was found that many of the conditions could not be laid down with any certainty until a large amount of research work had been done, particularly with regard to rupturing capacity for large sizes and safety of insulation. A comprehensive research is, therefore, being undertaken by the Elec. Research Assocn., and when the results of this work are available it may be possible to extend the specifications. In the meantime, however, they should be of considerable use to the Industry.

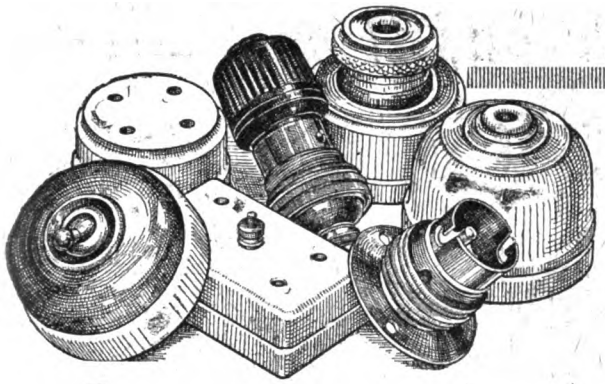
It is recognised that the breaking capacity of switchgear is dependent on many factors other than the k.v.a. to be broken, and it is necesesary to take in consideration all these factors in deciding on the size of control gear to be employed. The specifications do not include switches and circuit breakers for use with series motors, circuits of high inductance or traction circuits, all of which may require a higher breaking capacity than is specified therein. A distinction between an isolating switch, a switch and a circuit breaker is laid down as follows:—"An isolating switch is intended only for interrupting the circuit when there is no load-current. A switch is suitable for breaking a load-current; and a circuit breaker is suitable for interrupting a short circuit." A number of terms used in modern switchgear practice have been defined, and a series of standard sizes has been included. Dimensions of back connections and the distance apart of the stud centres of knife switches have been agreed upon so as to secure a reasonable amount of interchangeability without interfering with details of design. Since it is not practicable to take out a complete range of tests on every switch or circuit breaker, the tests have been divided into two categories, *i.e.*, tests which are carried out on every switch or circuit breaker and those which are carried out only on a switch or circuit breaker of a type.

The issue of these specifications marks a distinct step forward towards the simplification of switchgear generally. As usual, the co-operation of the interested electrical Assocns. has been secured, as well as that of Govt. Depts., the Inst. E.E., the Electricity Commissioners and the N.P.L. The Committee have also had the benefit of the assistance of Mr. E. B. Wedmore (Director, B.E. and A.I. Research Assocn.), and Mr. C. H. Wordingham, C.B.E.

Labour Co-partnership Assocn.—Yesterday the cause of industrial harmony was further advanced by a conference at the Crystal Palace, organised by the Labour Co-partnership Assoc., in conjunction with the Industrial Christian Fellowship, the Industrial League and Council and the Welfare Workers' Institute. The morning session was devoted to "The Spiritual Aspect of Industry," and the afternoon session to "The Ideal Industrial Life."

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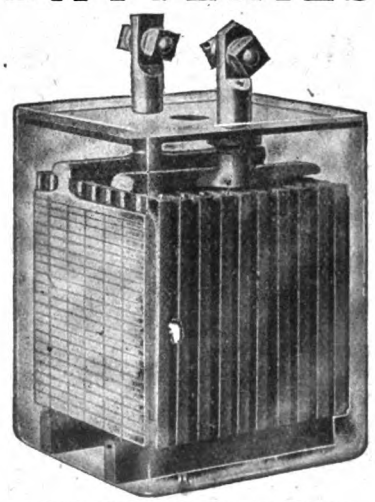
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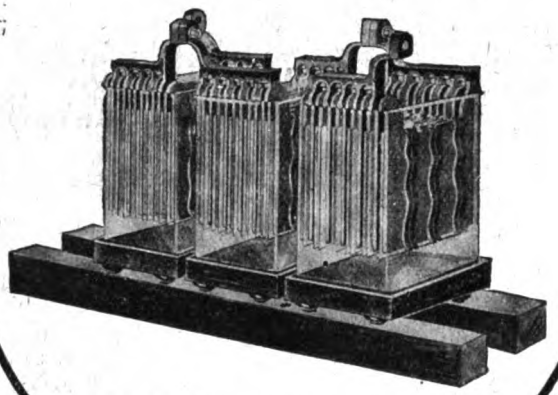
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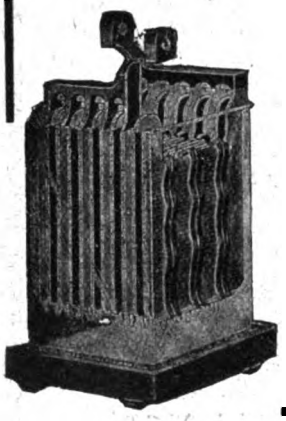
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Electricity Breakdowns.

With the cessation of Summer Time, and the consequent darker evenings, there has been a regrettable recurrence of breakdowns in the public supply of electricity in several quarters. As I have previously urged in these columns, it should be the aim of every supply station engineer to ensure, as far as is practicable, an uninterrupted service. Accidents will happen, and mains will fail on occasions; but, with modern plant, good quality cables, and a proper system of testing and inspection, followed by methodical maintenance work, there should be very little risk of serious disturbance of the service. Within a week three breakdowns have been reported—in Finchley, Ashton-under-Lyne and Bingley respectively.

In the case of the last-named, there would appear to be ample cause for complaint on the part of electricity consumers, since this breakdown is by no means the only one from which they have suffered annoyance, and a formal complaint has now been lodged with the Electricity Commissioners. It seems that the electricity supply for Bingley is received, in bulk, from neighbouring Keighley, by way of twin overhead cables, one of the latter being held in reserve against the possibility of such a breakdown. Notwithstanding this precaution, whenever a fault develops in the particular cable which is in use, the duplicate cable generally happens to be unfit for service at the same time. To the average electrical reader the difficulty does not appear to be of any serious magnitude, and it is a pity that electricity supply should be allowed to fall into such local disrepute through neglect of simple remedies.

Coal Strike Echo.

The coal stoppage was responsible for much regrettable loss of trade, wages and prestige, which is now self-evident to the majority of the participants in the struggle. Among other things it created some curious situations in regard to contracts which could not be carried out. A case in point was recently heard at Wrexham, where the Corporation sued a large electricity consumer for £160 alleged to be due for electricity supplied during the June quarter. It seems that the defendants took electrical energy from the Corporation on the maximum demand system. During the strike the Board of Trade issued an order that the supply of electricity was to be restricted to 50 per cent. of the normal quantity. For the defendants it was urged that this embargo prevented the Corporation from carrying out their contract with them, and that they were therefore only liable for payment for the quantity of electricity actually consumed, some £87 worth. The Town Clerk urged that, whilst sympathising with defendants, the coal stoppage had involved the Corporation and ratepayers in considerable loss, and they must be fair to both parties. After a lengthy hearing, the magistrates adjourned the case, with a suggestion that the parties get together and endeavour to compromise.

Enterprise at Leeds.

Congratulations to Mr. C. N. Hefford, manager of the Leeds Corporation Electricity Department, upon his foresight in extending the city's supply mains to the district south of the River Aire, thus encouraging a future industrial lead in this area, and, at the same time, choosing a somewhat novel route for the new mains which will cause a minimum of interference with traffic and disorganisation of existing subterranean services. The proposition is to lay new cables capable of transmitting some 50,000 e.h.p. along the bed of the River Aire from behind the Electricity Works in Whitehall Road. Crossing the Aire at the spot known as the Bondman Weir, the cables will proceed under the Dark Arches, along innumerable arches under the Midland Railway, then the arches of the North Eastern Railway to Little Neville Street, and thence through to Victoria Road, where they will effect a junction with other cables laid over the Victoria Bridge.

The method of laying will consist of dredging a trench along the bed of the river, into which the cables will be dropped and covered with broken ballast for protection against injury. Where the cables pass through the weir a small dam will have to be constructed. If the Department had not hit upon this somewhat novel plan it would soon have been faced with a formidable problem. The alternative route was along Aire Street, in front of the City Square, and down Bishopsgate to Little Neville Street. At the present time these thoroughfares are already crowded, as to their immediate sub-soil, with numerous mains of all descriptions, while in some places the electricity supply mains have had to be laid in three tiers. In any event, the laying of additional mains along these busy thoroughfares would have involved serious traffic dislocation, so that the projected plans above detailed will effect quite a considerable economy both of money and time, to say nothing of irritation.

The Commercial Engineer.

An article in a lay contemporary deals very forcefully with the growing need for commercialism in the training of the young engineer or engineering student. I heartily concur with the views expressed in the article referred to; the lack of commercial instincts in even our most brilliant engineers in the past has robbed them and the nation of the best fruits of their endeavours. It is a fact borne out by experience of engineering works and engineers, both little and great, that the most experienced and cleverest engineer is seldom, if ever, a good man of business. Some of the most ingenious inventors and designers I have met in the course of a varied career could not tell

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you the approximate cost of a screw, nut or bolt, nor the current market price of castings. They had no idea of costing, nor of systematic recording and checking of manufacturing processes. Their idea of getting on with a new job was generally to summon an informal gathering of shop superintendents, foremen and others, describe as clearly and simply as possible what they wanted done, and then leave it to the practical men to work out their own salvation.

I believe it is a fact that genius is always a little mad; certainly it is true that technical genius is seldom accompanied in the same individual by commercial sense. Thus we have inventors wasting their valuable time and building up disappointment for themselves, either by concentrating on some problem which has already been solved, or attempting to produce a novel machine or piece of apparatus for which there is no prospective market or demand. True, it is difficult for the technician to concentrate on his work if he has to think in terms of pounds, shillings and pence, but, if taken early enough, the habit can be inculcated, until in later and more mature years it becomes second nature.

The really competent commercial engineer—*i.e.*, the man who, whilst in the front rank of his profession, is also a shrewd business man, and conducts his engineering negotiations with an eye to the financial interests involved—is a jewel without price to any large industrial concern to-day. He can save thousands of pounds in the course of a few months, simply by his business instinct, which automatically indicates to him what proposals are foredoomed to failure and which are most likely to turn out financially sound. Such valuable experience can only be gained by serving a dual apprenticeship in one's early and most impressionable years, and it would be an advantage to the nation if the regular engineering curriculum included a fair proportion of commercial training and experience in the fields indicated. The time thus spent would be well repaid in after life, and the industry would profit enormously in the long run.

ELEKTRON.

Correspondence.

To the Editor of ELECTRICITY.

DEAR SIR,—As an old reader of your valued paper, and more particularly as an interested reader of Mr. Edward Hughes' "Answers to the questions set in the City and Guilds Examinations in Electrical Engineering," I am writing to ask you if it is at all possible to explain, a little more, some of the obscure points in a few of the questions. For instance, this week—October 7, 1921— in answer to question 4, I cannot quite follow Mr. Hughes' table in comparing the four systems; in column A, I^2R loss per line $\frac{1}{8}\left(\frac{P}{v}\right)^2 \frac{k}{A_1}$—where does the $\frac{1}{8}$ creep in? I cannot quite follow how he arrives at all these fractions in determining the losses for any of the systems, and feel that a fuller explanation of his table would benefit a good many of your readers, who, like myself, endeavour to keep themselves from becoming "rusty" by reading, intelligently, your excellent journal.

There must be a good number of your readers studying for the City and Guilds examinations to whom an explanation would be helpful.

One more question. Would Mr. Hughes be able to give such long, carefully worked out answers in the time allotted for answering the questions?

Yours truly,
"INTERESTED."

9, Stanmore Lane,
St. Cross, Winchester, Hants.
October 10, 1921.

TELEGRAPHY.—GRADE I. (1921).

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in April, 1921.

(*Continued from page* 572.)

Q. 7.—Three wires of 2, 3, and 6 ohms resistance respectively are joined in parallel; what is their joint resistance? If a battery of 4 volts electromotive force and 3 ohms internal resistance is connected to the above three wires joined in parallel, how much current flows through each wire?

A. 7.—The joint resistance of three resistances in parallel is equal to the reciprocal of the sum of their separate conductances. The conductances of the three wires in question are $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{6}$—respectively, and the sum of the three

$$= \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$
$$= \frac{6}{6} = 1 \text{ ohm.}$$

Hence joint resistance which $= \frac{1}{\text{sum of conductances}}$
$= \frac{1}{1}$
$= 1$ ohm.

When a battery of E.M.F. 4 volts and 3 ohms internal resistance is connected to the above three wires joined in parallel, then by a simple extension of Ohm's Law a current of $\frac{4}{3+1}$ that is 1 ampere, will flow from the battery. This current will divide through the three wires in proportion to their conductances, viz.,

$\frac{1}{2} : \frac{1}{3} : \frac{1}{6}$: or 3 : 2 : 1

Hence current through 2 ohm wire equals $\frac{3}{6} \times 1 = \frac{1}{2}$ ampere

Hence current through 3 ohm wire equals $\frac{2}{6} \times 1 = \frac{1}{3}$ ampere

Hence current through 6 ohm wire equals $\frac{1}{6} \times 1 = \frac{1}{6}$ ampere

Q. 8.—What are the advantages of double-current working? Give a diagram of two stations double current simplex, and show by means of arrows the path of the current when the down station is sending and the key is depressed.

THE TELEGRAPHISTS' GUIDE. By BELL and WILSON. New (8th) edition, revised and brought up to date by a C.T.O. expert of high standing. 20th thousand. Profusely illustrated. 5s. 6d net, post free from ELECTRICITY Office. The standard for Grade I.

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A. 8.—The advantages of double-current systems over single-current systems are :—

(1) The reversal of the current quickens the static discharge of the line.

(2) The reversal of the current eliminates residual magnetism in the cores of the relays.

(3) The tongues of the relays are set nearly neutral, their most sensitive adjustment.

(4) Double-current systems are to some extent self-adjusting, as variations in the current strength affect marking and spacing currents alike.

Advantages (1), (2), and (3) enable working to be conducted over longer distances, or result in increased speed of working; and advantage (4) enables signalling to be conducted with weaker currents and in spite of considerable line disturbances.

The connections of two stations, double current simplex, are shown diagrammatically in Fig. 4. The down station key is shown with its switch in the "send" position and with the key lever depressed; the receiving relay being connected to the middle back terminal is therefore disconnected. At the up station the D.C. key must have its switch in the "receive" position so that the receiving relay there may be in circuit and the up station main battery disconnected. The arrows show the path of the current from the positive pole of the down station battery back to its negative pole. The current at the up station passes through the relay from (*U*) to *D*, and therefore moves its tongue to the marking stop, closing the local circuit and actuating the sounder.

(*To be continued*).

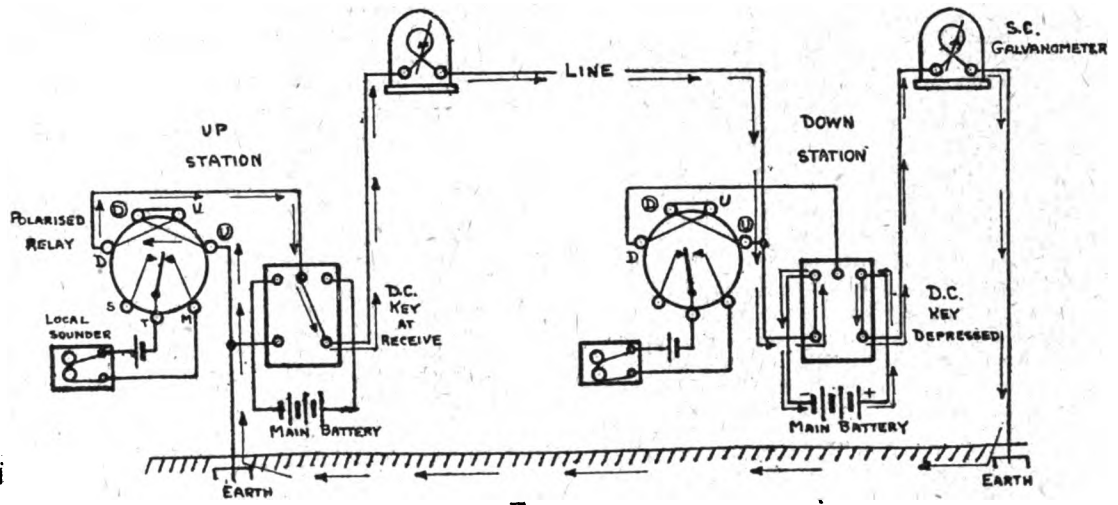


FIG. 4.

THE "SENTINEL" EXCESS CURRENT INDICATOR.

The "Sentinel" Excess Current Indicator is a simple device designed to control an electrical circuit of any predetermined capacity from ¼-amp. upwards, and consists of a cast-iron box with glass inspection window, containing a glass tube through which a suitably graded resistance wire is threaded. The resistance wire is coated with white Urea crystals, and retains its white colour indefinitely, until the wire is subjected to a definite excess current, when, after at least two or three minutes, the crystalline coating melts, and its colour changes to a dark brown.

Urea crystals have an absolutely definite melting point, and thus extreme accuracy is secured. Furthermore, if required, the indicator will operate on an increase of current amounting to only 10 per cent. of its normal capacity. The current at which the coating changes colour is only one-fifth of the current at which the wire fuses; hence there is no danger of the latter happening, as the main fuses are rated to operate at a lower current than this. Instantaneous short circuits do not affect the instrument in any way. The indicating wire is enclosed in a glass tube, so that, when necessary, a new element can be inserted without damaging the coating.

A "Sentinel" Excess Current Indicator, submitted to one of the principal electric supply undertakings in the country, was subjected by them to exhaustive tests, as a result of which they expressed their entire satisfaction as to its operation. Below is given an extract from the official tests carried out by this Corporation :—

"On test it was found that with 1.8 amperes for six hours no change was apparent in the crystals. The current was increased to 2 amperes and after two minutes the crystals at the centre of the wire—for about ½-in. in length—melted. After one hour there was no further change. The current was then increased to 2.2 amperes, and after two minutes the crystals started to melt to within ¾-in. of the terminals. The current was then increased to 2.3 amperes, when the crystals completely melted, leaving the wire a dark greenish-brown colour. A sample of the above wire was put into an oven, and when a temperature of 140 degrees C. was reached the crystals started to melt; after four minutes the crystals were completely melted. Potential drop at 1 ampere was 0.337 m/v. Two samples were tested, and the melting of the crystals appears to be quite definite at the current stated."

The device, which is made by Electrical Utilities, Ltd., of 1-3, Shellgate Road, Battersea Rise, S.W.11, can be arranged for any current from ¼-amp. upwards, and to indicate with an excess current of 10 per cent., 25 per cent., 30 per cent. or 50 per cent. above the normal. It is useful to show when a contract has been exceeded.

English Electric Co.—Lady Ellis, wife of the chairman of the English Electric Co., Ltd., opened the club-house equipped for the use of the girl employees of Dick, Kerr and Co., Ltd., on Oct. 12. Mr. Livingstone, the works manager, presided. The club, corresponding to that established two years ago at Ashton Park for the firm's male employees, as a memorial to comrades who died in the war, is situated in Strand Road. Its work is to include debating and dramatic societies, classes for dancing, teaching of various crafts and hobbies, and occasional lectures.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 126.

What are the essential principles to be observed when designing electro-magnetic relays to ensure quick action? I desire to design a relay with 1-100th second period of contact. This is to operate on 12 volts, being connected to this supply through leads having a resistance of 3 ohms. The circuit closed will carry 15 amperes at 40 volts. I would like details of a suitable design with a method of verifying the accuracy of the relay to operate in the period stated. I would also appreciate the name of a technical book or paper from which I can obtain details of designs of this nature.—"B."

QUESTION No. 127.

I desire to have electric light and electric motors fitted in my boot factory. I would like you to point out the most essential features to be considered when drawing up a specification to enable the correct type of motor and fittings to be installed. The supply is 500 volts, three wire.—"Astatic."

(Replies to Questions Nos. 126 and 127 must be received not later than October 29, 1921.)

Answers to Questions.

REPLIES TO QUESTION No. 124.

The first prize (10s.) has been awarded to "D. J. Wilson" for the following reply:—

To find the direction of phase rotation at any instant on a polyphase A.C. system will be a difficult matter for the practical electrician.

If it is desired to be able to state with certainty the direction of rotation of induction motors, then the following method will be far simpler, and can be recommended. It is presumed that the workshop has a test-bed, nothing elaborate; say a single way fuse board and line switch (to be used in conjunction with spare starters, etc.), together with one pair of adjustable slide rails.

Assuming a three-phase system, the bus-bars in the power house should be painted, or designated, red, white and blue, after which they should be traced to the workshop by means of the megger or other testing set.

All spare motors in the workshop should now be run up, and their direction of rotation noted when the starter leads (from left to right or top to bottom) read red, white and blue. Where the direction of rotation is not clockwise (pulley end), the starter leads must be pushed back into the carcase and drawn out in their new positions, after which the colours may be painted upon the braiding and carcase. With the smaller motors, when the starter leads all come out together a block of fibre may be drilled to suit the leads and screwed upon the carcase. Painting the braiding or even stamping the cable lugs might suffice in some cases.

In the case of Star-Delta motors the leads forming the neutral must, in addition to being painted red, white and blue, be easy to pick out. New motors should also be treated this way immediately on arrival.

If time allows, the colours can be transferred to the switch leads when changing the motors, but since this may take years the principle distribution boards should next be tested. The colours should be marked in a conspicuous place with new work, the colours should read from top to bottom, but in phasing out existing plant this will at times be impossible. From the boards the motors must be tested, and the colours painted upon the leads and carcase, so that when in for repairs they can be reinserted in their new positions.

The braiding at either end of the starter to motor cables must next be painted, and also the incoming switch mains. With new work coloured cable will be used.

For clockwise rotation the respective colours will be connected together, while for counter-clockwise any one line must be so treated.

This method was commenced about two years ago with a three-phase 2,000 kw. plant to save time when changing motors, and has given every satisfaction, and also assisted to balance the lighting load.—"D. J. WILSON."

[No second award is made.]

SUBMERSIBLE ELECTRIC MOTORS FOR MINE'S PUMPS.*

BY A. J. RAMSAY.

In referring to the importance of the question of pumping in all phases of mining work and the disastrous stoppage of work in the mining industry, with the consequent flooding of the mines or lower workings in a number of areas, the author expressed the hope that he in this paper would contribute something to the solution of the various problems with which the mining engineer was faced in bringing conditions back to normal. He also hoped to show that it was possible to install pumping plant in future that would not be affected by flooding due to stoppage or accidents, and which could be relied upon to work satisfactorily after indefinite periods of submersion. Although the paper was confined to the various pumping operations met with in mining work, he was confident that the submersible motor could be applied also to other duties.

DEVELOPMENT.

One of the greatest problems that has engaged the attention of electrical engineers during the present century is a method of insulating the windings of electrical machines so as to enable such machines to work satisfactorily in damp or wet positions. Prior to the invention of the submersible electric motor by Macdonald in 1908, the only method attempted by manufacturers of dealing with the problem as applied to electric motors was to construct what were termed "watertight machines." These machines were, of course, totally enclosed, with special precautions taken to keep moisture from entering the interior. Even the best designed machine of this type is very unsatisfactory, as the alternate heating and cooling of the iron and copper within the machine has a very damaging effect on the insulation of the windings. Further, the output of machines of this type is limited on account of the amount of copper and iron required for a given output, and, above a medium power, the weight and cost become prohibitive.

Macdonald succeeded in designing a motor in which it would be possible to use water or other liquid as a cooling agent. The principle on which he worked, which holds the field to-day, was to pass water completely through the

*Abstract of paper read before the North Staffordshire Inst. of Mining Engineers and first published in *The Mining Electrical Engineer.*

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windings of the machine and to insulate the conductors for these conditions. The first machine produced was a crude arrangement, but it demonstrated the practicability of the idea. The motor-frame was open, admitting water to the interior, and it was necessary to have the motor submerged at all times when working in order to obtain the necessary cooling for the windings. The design of the bearings, also, would not be suitable for continuous operation. Since Macdonald's time, and particularly since the year 1914, great changes have been made in the design and method of application for various duties

The present paper is confined to a general description of the modern submersible motor, particularly as applied to pumping plant for use in mines, the motor in all cases being of the squirrel-cage induction type. The chief points that a mining engineer looks for in an electric motor for which he is to be responsible are :—(1) Reliability, particularly as regards the risk of the motor being flooded, and when installed in a fiery mine ; (2) portability, particularly with reference to sinking-pump sets, and those for use in headings ; (3) low maintenance cost ; (4) highest possible efficiency ; (5) moderate capital cost ; (6) minimum space ; (7) possibility of running for long periods without attention ; (8) remote control. These advantages can all be claimed for the submersible motor.

A Submersible and Single-Stage Pump.

The following description is of a submersible motor direct-coupled to a single-stage centrifugal pump of the portable type. Its chief characteristics were as follows :—Pump, 750 gallons per minute, at 75 ft. T.M.H. ; motor, 30 h.p., 1,430 r.p.m., three-phase, 50 periods, 220 volts. The maximum dimensions of the set were : Length, 52 in. ; width, 27 in. ; height, 37 in. ; total weight about 17 cwt. The pump was coupled direct to the motor-frame, thus making a very compact unit. The shaft was of manganese bronze, with the squirrel-cage rotor and the gun-metal pump impeller mounted thereon.

With regard to the rotor construction, the end rings are brought close up to the iron at each end. This is important, for the following reasons :—(*a*) In the final assembly of the bars and end rings the core is compressed by these members right up to the periphery of the core-plates, thereby preventing the spreading of the plates, which would open up pockets for corrosion. (*b*) If the bars passed the edges of the core, with a gap, before linking with the short-circuit rings, according to usual practice for an air-machine, the water losses which are inevitable would be greatly increased. (*c*) A very robust construction is obtained, and the exposed surfaces are reduced to a minimum. The bars are made of drawn copper, and are enamelled where they pass through the core. Each end of a bar is drilled in the centre for a distance equal to the axial length of the end ring ; steel pins are driven into the holes, thereby swelling the ends of the bars, and making positive contact with the end rings. Before assembly, the ends of the bars and the holes in the rings are tinned, and after assembly the whole of the joints are sweated up. There is no danger from heating on account of the water cooling, so that there is no trouble from sweated joints. For larger units, however, the bars are welded to the rings.

The impeller is of the single-inlet type, cast in one piece, with blades having the form of involutes at entrance and exit. The motor-stator is a totally-enclosed cast-iron frame, and the core is assembled under pressure with stiff-ribbed end-plates which completely cover each end of the core. The winding takes the standard form for three-phase, single-layer, star-connected type, with a two-plane overhang.

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.) and orders will be appreciated.*

Boiler Inspection and Maintenance.—By Reg. Clayton. 118 pp (Pitman 2s. 6d. net.)—This book is one of Pitman's Primer series, which has now grown to such dimensions that most of our readers probably possess at least one, dealing with the equipment in which he is most interested. The general scope of each volume is therefore probably well known and in no case, so far, has the matter done injustice to the title. In this instance the same can be said, and many boiler attendants, mechanics, students and others interested in the safe, efficient and economical supervision of boiler-house plant can profit by a study of its pages. All the chief boilers in use on land are dealt with fairly fully, while, with the exception of economisers, which are also dealt with in some detail, accessories are briefly, but very concisely, touched on. Fuel economy, as such, does not come within the scope of this work, but the hints on care and upkeep should materially assist in the preservation of boilers in a state of reliability and efficiency.

The Electric Lighting of Shop Windows. By G. K. Fletcher, 38 pp., 8 typical window-lighting illustrations. Benn, 5s. net.)—The aim of the author appears to be to explain to shopkeepers in simple language the principal rules underlying the use of electric light in shop windows and it should prove a good guide as to the choice of new installations as well as to the improvement of existing ones. The information given is quite sound, and no doubt the estimates for alternative schemes given in Chapter VI. will be of assistance to the shop-keeper, who is now able to determine in broad outline, the lighting scheme most suited to his style of window, and can specify to his contractor what he wants. The possession of this knowledge by the client should be of assistance to the contractor, who, unless he be a rogue, appreciates his client having some idea of what he wants. The author does not advocate the client dictating to the contractor as to details of the work.

Central Station Rates in Theory and Practice. By H. E. Eisennmenger. 328 pp. (Drake, Chicago ; Rentell. 15s. net.)—The text of this book recently appeared as a comprehensive serial in the *Electrical Review* (Chicago) and as now published should be useful to every student of electric rates, to the beginner as well as to the expert. A useful feature has been the relegation of the more elementary and more advanced portion of the work to appendices. The fact that the book is American does not detract from its value in other parts of the world, as rates prevailing throughout the world have been studied by the author in conjunction with others, and, as Mr. S. E. Doane (Chief Engineer, Nat. Lamp. Works of the American G. E. Co.), writes in the foreword, "Rates should never be so high that the prospective business is unable to make use of the facilities. Rates must always be less than the price for which each user can serve himself. Rates can not be apportioned on an average basis to fit all needs. There must be shrewd intelligence employed in the making of rate schedules which will bring to the public the maximum returns for every dollar it spends without denying to the utility the maximum return to which it is entitled for the clever use of the equipment in which it has made its investment." That is to say, the principles determining the fixing of equitable rates are the same the world over. Mr. H. E. Eisenmenger is the manager of the Techno-Service Corpn., New York. Although he is responsible for the bulk of the book, there is a section on "Public Utilities and Public Regulation" by Mr. S. F. Walker (former Assoc. Editor "Rate Research") This latter section applies more particularly to American practice.

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RIMER-NOSED PLIERS FOR ELECTRICIANS.



We have recently tested a pair of the new patented rimer-nosed pliers manufactured by Wynn, Timmins and Co., Ltd. (Century Works, Birmingham), and find them most handy and satisfactory for the removal of the internal burrs which are caused through cutting off steel conduit tubing by hacksaw. The pliers are of the ordinary approved side cutting pattern universally used by electricians, with this difference, rimer-cutting edges are provided on the nose. Thus a combination tool is provided, and the electrician's kit can be relieved of round or rat-tailed files, which are generally necessary for the smoothing of cut tubing to prevent the cutting, damaging or stripping of the insulation of cables or leads, when being drawn through the conduit. The pliers can also be used by plumbers for rimering out the insides of lead piping when making joints.

The company are known to many electricians for their Heart Brand cutting pliers, and we have no hesitation in suggesting that they should in their own interests become possessed of the new rimer-nosed pliers.

Various Items.

Telephone Appointments Vacant.—We would direct the attention of our telephone readers to the Situatione Vacant column in which they will find particulars of certain vacancies which have to be filled at an early date.

South Africa.—Tenders are invited by the Durban Corporation for house service S.P. and D.P. ironclad fuses, combined switches and fuses, S.P. switch-fuses for sub-station use, and for a 25 k.v.a. 50-cycle 3-phase transformer. Particulars from D.O.T., Room 49.

Sound Advice.—Big orders and important contracts result from advertising in trade and technical journals. The B.A.T.T.J. Handbook is a valuable guide, giving just the particulars an advertiser needs. 1s. post free of the Secretary, British Association of Trade and Technical Journals, Ltd., Sicilian House, Southampton Row, London, W.C.1.

Institution of Rubber Industry.—The inaugural meeting took place yesterday under the chairmanship of the President, Mr. J. H. C. Brooking. In addition to that interesting meeting we note that many valuable and instructive papers will be read during the winter, and social functions are to be arranged. Particulars from the Secretary, Charing Cross House, W.C.2.

Belfast.—In connection with the recent troubled meetings of the Corporation relative to the city's electricity undertaking, it is of interest to note that the misunderstandings appear to have arisen owing to some of the Councillors being under a misapprehension regarding the obligations of the consulting engineers, who naturally are under no agreement to give the Council expert *financial* advice.

S.E. Lancs. Electricity Supply.—Radcliffe Council are joining the S.E. Lancs Board for the manufacture of electricity in bulk, and a step in the direction of communal interests has already been taken by the local electricity station being linked up with the Lancashire Power Co.'s works at Outwood and with Bury. Radcliffe Station will probably be used only as a distribution centre before long.

F.T.C.O.S.A.—The tenth annual dinner of the Finsbury Technical College Old Students' Assoc. will be held at the Engineers' Club, Coventry Street, on Sat., Nov. 12; when the chair will be taken by Professor G. T. Morgan, O.B.E., D.Sc., F.R.S. Old students of the College may obtain tickets (price 10s. 6d. each), from the Hon. Sec., H. P. Guy, 209, Northumberland Park, Tottenham, N.17.

Annual Dinner.—The third annual dinner of the members of the Executive Council of the Electrical Power Engineers' Association will be held at the Hotel Cecil on Saturday, the 29th inst., at 6p.m. It will be a morning dress function, and ladies are cordially invited. For particulars as to tickets, early application should be made to the Secretary, at 102, St. George's Square S.W.1. It is sure to be well attended.

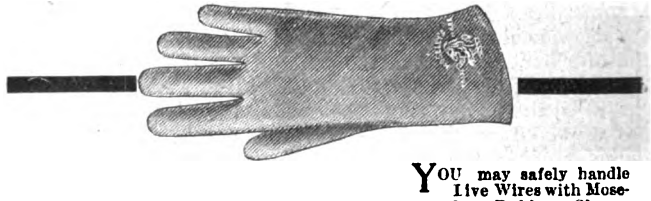
Lancaster.—The Corporation are opposing the scheme for the formation of an area embracing Barrow, Millom, Grasmere, Kendal, Bootle, Ulverston, Carnforth, Morecambe, Lancaster and Kirkby Lonsdale with Barrow as the generating centre. It is considered the proposed area is too scattered, and, having in mind the cost involved in transmission, distribution, etc., it is probable an alternative scheme, with Lancaster as a centre, will be submitted.

British Standard Channels and Beams.—The British Engineering Standards Association has just issued a report (No. 4—1921) on the dimensions and properties of British standard channels and beams for structural purposes. (Rentell, post free, 1s. 2d.) This report completes the preceding one by the inclusion of the details of geometrical properties, such as moments of inertia. Particulars of the dimensions of the sections with their areas, weights, etc., are, of course, retained.

Trade Notes.

The Metropolitan-Vickers Electrical Co., Ltd. (Trafford Park, Manchester), have issued a showcard to popularise their "Cosmos" radiant fire. The heads of two happy children appear in the beam of radiant heat emitted by the fire, and the only words appearing are "Cosmos Radiant Fire" at the top, and "The Glow of Happiness" at the bottom. In our opinion it is a most effective design with a direct appeal. It is unencumbered with matter calculated to distract attention from its main object. It expresses warmth and satisfaction, but unfortunately it is possible to read into it a recommendation for radiant fires in nurseries—a use to which such fires have some similar disadvantages to coal fires. The Company are also issuing a new envelope enclosure price list (No. 4150–4), also dealing with the "Cosmos" radiant fire. Retailers are being provided with both these publicity issues over-printed with their own names and business addresses.

The Edison Swan Electric Co., Ltd. (Ponders End, Middlesex), have produced a broadsheet entitled "Light on the Subject." It is devoted to a bold illustrated account of the Ediswan lamp Press and Poster Advertising campaign. Included is a P.C. for the use of contractors and dealers who are thereby invited to communicate with the Ediswan Co., stating their requirements in over-printed literature, showcards, electros (for their own advertising), and various signs (enamelled, illuminated or flashing), etc.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
OCTOBER 28, 1921.

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THE PROBLEM OF RESTORING VITALITY TO THE ENGINEERING INDUSTRY.

The Government is doing all it can (including the taxing of toy magnets and doll's eyes) to reduce unemployment and restore our trade, which, as no one can fail to appreciate, is in a most serious condition. When all is said and done, however, there is little that this or any other Government can do of a permanent nature, but the following are undoubtedly the essential features and conditions of a national effort to restore prosperity to the country through the really staple industry—engineering. The following conditions were adopted on the 19th inst. by the members of the British Engineers' Association in full conference under the chairmanship of the President, Mr. Nevill Gwynne:—

1. The loyal co-operation of labour in a great national effort to revitalise our industries and commerce which are the only possible sources of its own well-being.

2. The repudiation by the Trades Unions of the declared policy of their extremist sections to render the system of capitalism and private enterprise unworkable.

3. The institution of compulsory secret ballot by the Trades Unions.

4. The reduction of cost of production by amending the conditions affecting the output per £ of wages paid.

5. The careful consideration of a national trade policy more in consonance with the new conditions with respect to foreign competition in our home market and the raising of tariff walls abroad tending to shut out our exports.

6. The development of the home market and the confinement to this country of contracts involving the expenditure of public monies.

7. The development of markets within the Empire.

8. National economy.

9. Reduced taxation of wealth-productive industries.

10. Unemployment relief work to be of a reproductive nature to the greatest extent practicable.

11. The payment of doles uncompensated by work done, to be reduced to the minimum.

12. Cheaper coal, valued in terms of heat units.

13. Due consideration to be paid by the Government to the possible effects upon industry of a policy of deflation.

14. The taking of drastic measures to reduce the cost of living in so far as it may be due to profiteering by the few at the expense of the many.

15. A more complete and better organisation of industry for its good government from within.

Subsequently, Lord Weir delivered a most important speech in the course of which he said that the two chief factors to which he wished to call attention were that countries who were able to buy were not buying from us, and that because our prices were regarded as artificially high customers were restricting and postponing their demands. Whatever might be the handicap of exchange, of frozen credit, or war dislocation, there was a definite amount of foreign trade available, but we were not getting it. Someone else was. Infinitely worse was the fact that there was a definite amount of home trade available, but we were not getting that, and someone else was. What was the character of the statesmanship which concentrated the efforts of British brains on credit schemes, financial measures, and relief work, and ignored entirely the lessons of our own trade returns? Which was the best statesmanship—to grant British credit or guarantees of credit to a foreign country, or even to a British Colony, to enable it to purchase from Glasgow a huge bridge which would be built of imported steel, or to tell the British steel maker and his workers that these guarantees would be withheld until the steel maker and his workers could arrange between themselves to produce that steel at home and give the necessary employment? He wanted a programme not to relieve unemployment but to provide employment.

The Labour Party asked the Govt. to provide "work or maintenance." Apart from the fallacy that a Govt. could carry the community on its back, in distinction to the real truth that the community carries the Govt., the suggestion would mean, for example, that there would be local schemes for relief in Lanark giving unproductive and inefficient employment to miners, ironworkers, and labourers, working alongside closed pits and ironworks, while Glasgow harbour would be filled with vessels bringing in foreign iron smelted with foreign coal. That was the type of ineffectual and purblind policy likely to emerge from the manner in which one heard that the Govt. proposed to deal with the situation. The main question was one of costs of production in different countries. Apart from wage rates, wage costs were inflated to-day by unjustifiable working conditions due to the Trade Union pressure of the last few years. Few had yet realised the true incidence of the shorter working week on costs and prices. He estimated the increase in cost of British products last year due to the shortened week at over £200,000,000. The experiment had been a failure. Output had not increased, but had gone down approximately in proportion to the hours. To reduce costs in a normal year by £200,000,000 without affecting weekly earnings would be the most effective help that could be given to our industries to-day. Miners' wages would remain low until the hours were increased, and not till then would the blast furnaces be able to start and give employment.

He regretted that reductions in wage rates were chosen as the first step towards cost reduction. If the abolition of restrictive conditions were now discussed with the Trade Unions in a spirit of frankness, and an agreement was reached, any further wage reductions should be viewed in association with the cost of living, subject to the possibility of drastic economic difficulties intervening. He suggested that they should advise the Prime Minister to concentrate on restoring vitality to their industry by reduction on cost, and that this could best be secured by a revision of some of the working conditions in the first instance, and by wage reductions only as a last resort. Labour looked to the Govt. to revive trade. No Govt. could do it. They should tell the Prime Minister what they honestly believed to be necessary, and ask him to trust the workmen of the country by telling them the truth. Our workers had never yet failed in judgment on big issues straightly put before them.

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LOW TEMPERATURE CARBONISATION.

On October 19, a Press demonstration of the above system of Low Carbonisation, Ltd., was given at the company's works at Barnsley. The demonstration was very satisfactory, and proved beyond doubt that the product—Coalite—is an excellent fuel of high calorific value and great heat radiating power, so that both as a domestic and steam-raising fuel it has the necessary and desirable calorific qualities, as well as being quite smokeless. Moreover, being made from a washed mixture of 30 per cent. of coking coal and 70 per cent. of usually wasted non-coking coal, the amount of final ash is kept down to about 5 per cent. A ton of coal gives 14½ cwt. of the new fuel, and, in addition, the gas which is given off deposits, when cooled, 20 gallons of tar; 15 lb. of sulphate of ammonia is made from the ammoniacal liquor; and 6,000 cubic ft. of gas possessing a calorific value of 750 B.Th. U. per cubic foot, which is eminently suitable for use as an enricher of ordinary gasworks gas, whose product of monoxide from gas coke can be thus exchanged to heat the retorts of the new system, which do not call for high temperature heating, and can therefore be heated by poor gas of 550 unit value.

The plant at Barnsley is considerable, having been laid out to deal with a large lay-out of carbonisation ovens. The difficulties in making low carbonisation fuel have been many, the chief obstacle to success having been the swelling of the coal at low temperature heating and its jamming fast in the retorts. Then, when at last extracted, it would flash to flame as soon as it touched atmospheric air, and if quenched it fell to dust.

Some forty retorts had been tried before success was secured. Doubtless these experiments taught many useful facts, and, when the present success was attained, it was by such simple methods that one can excuse the inventors who, after seeking vainly for Pharpar and Abana, suddenly fell into the Jordan and were made whole.

We need not describe the work generally. Coal conveyors, washing plant, tips, gas exhausters, and tar separators are all carried out by familiar and usual appliances. The system proper is all contained in one unit of carbonisation plant, built up of twenty cells or retorts of 10 cwt. capacity each, each flat retort measuring 9 ft. deep by 6½ ft. long and 11 in. wide, and separated from the next cells by narrow combustion chambers, in which burning gas jets heat the walls of the cells, and the hot gases pass to and fro in the passages into which the oven space is divided, and finally escape at their chimney.

Each cell is closed at the top and bottom by a curved sliding shutter, moved by rotation. These shutters when in the open position provide a free passage from hoppers above into the cells, and from the cells to cooling chambers below them. The hoppers each hold 10 cwt. of coal, which is brought to them by any suitable conveyor.

On opening the top valve or shutter this charge falls into the cell below, and the shutter is closed. After seven or eight hours in the heated cell the operation is complete, and the lower valve lets successively down to the cooling chamber below the two slabs of coalite. The cooling chambers are water-jacketed and airtight, and in them the coalite is deprived of most of the heat during the period of carbonisation of the next following charge of coal above.

The door is opened, and the coalite, now at about 100 deg. F., is discharged, cooled far below ignition or flash point, on a sloping floor, down which it slides to a conveyor, and is conveyed directly to wagons or a storage bin. This final conveyor waits installation pending the addition of the opposite set of 20 cells. Thus no time is lost in filling and emptying the retorts, and there is more than ample time to replenish the charging hoppers and cool the finished product.

Two slabs of coalite are above referred to as being discharged from each cell. It is just at this point that the chief interest of the system is centred. It is pointed out above that one great difficulty to be overcome has been the swelling of the coal in the retorts. This rendered discharge practically impossible, and the method of overcoming the difficulty is simple, and accounts for the *two* slabs.

Each cell has two middle plates in it, set about 4 in. apart and about 3 to 4 in. from the retort walls. There are thus two carbonisation chambers in each cell, and a central empty space bounded by the two perforated half-inch thick steel plates.

The two plates are so suspended by hinged links and kept apart by lugs below that, when desired, they can be brought together so as to widen the two carbonisation compartments. The plates are thus brought inwards before discharging a cell, and this leaves the two slabs of coalite free to drop into the cooling chamber as soon as the rotating shutter is moved to open position. Now, this inner space is kept down to atmospheric pressure by an ordinary form of rotary gas exhauster. The gas evolved from the charges is drawn away as formed, and prevented from finding its way through the outer brick walls into the oven flues, where it would burn and spoil the control of temperature. The perforations of the plate allow the gas free passage to the median space from all parts of the charge. And this explains the *two* slabs, and accounts for the success of the new retort system. These cells have worked some three months uninterruptedly, and with the novel cooling chambers have shown how coalite can be made of the right texture and non-crystalline, such as it would become if steam cooled. The gas burning or heating flues pass horizontally to and fro over the flat surfaces of the retort cells. The direction is downwards, and the temperature is maintained by a series of gas jets along the course of the flues. The finally escaping gas serves to heat the incoming air, so that the retort heating system is regenerative, and is carried out at an efficiency of, it is estimated, over 75 per cent.

There are many interesting points in the problem of low temperature carbonisation—such, for example, as the possibility of finding a non-porous material for the cell walls. Some day it is hoped to find this in, perhaps, a modified cast-iron.

But the plant seen is a success with ordinary commercially procurable slack, and the company are to be congratulated on having achieved this success.

It may be added that their product is quite firm, and tough and transportable; and, if any small were formed by rough handling and long travelling, the small can be dumped on the fire and will burn freely—unlike small coal, which would smother the fire.

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THE BEAMA DINNER.

Nearly 500 members and visitors assembled at the Savoy Hotel on Thursday, the 20th inst., on the occasion of the annual dinner of the British Electrical and Allied Manufacturers' Association. The Right Hon. Lord Ampthill, G.C.S.I., the president of the Association, was in the chair, and he was supported by a large number of men distinguished in the professional and industrial world, including Lord Vaux of Harrowden, Sir Edgar Walton, Mr. George Balfour, M.P., Sir John Aspinall, Brigadier-General Sir H. W. Thornton, the Hon. Sir Edgar Bowring, Mr. L. B. Atkinson, the Hon. J. McEwan Hunter, Lieut.-Col. the Hon. P. Pelletier, Mr. F. C. Wade, K.C., Mr. John Howard, the Hon. Sir Peter McBride, Sir H. Frank Heath, Sir C. Ellis, the Hon. Sir James D. Connolly, the Hon. Sir C. A. Parsons, Sir James Devonshire, Mr. H. C. Levis, Mr. Gerard Swope, Lord Meston, Mr. John Taylor, Sir W. Clark, Lieut.-Col. F. A. Cortez Leigh, Sir W. Noble, Sir J. E. Petavel, Mr. W. O. Smith, Mr. J. S. Highfield, Mr. H. Hirst, Mr. F. C. Gibbons, Mr. A. F. Berry, Mr. E. S. New, Mr. A. E. Tanner, Mr. B. Longbottom, Mr. M. J. Railing, Mr. F. H. Nalder, Mr. A. P. Wood, Engineer-Commander Dight, R.N., Sir Keith Elphinstone, Mr. L. C. Gamage, Lieut.-Col. C. Hardie, Col. P. D. Michod, Col. R. K. Morcom, Lieut.-Col. Pearson, Capt. Riall Sankey, Mr. S. Z. de Ferranti, Mr. J. McDonald Henderson, Mr. O. H. Smith, Mr. A. W. Tait, Mr. C. A. Vandervell, Mr. C. P. Martin, Mr. P. J. Pybus, Mr. D. N. Dunlop (director and secretary), and Mr. C. A. Weeks (assistant secretary).

Mr. G. Balfour, M.P., in proposing the toast "The Industry," said that up to the outbreak of the war the electrical industry was perhaps the worst paid private industry. It was impossible for them to obtain the reward of their labours when, as the result of foreign competition, they saw agents and works established throughout the country which depressed prices. It was a fact that, so long as wages were at a high level, they could not support the industries of the country, and therefore wages must be reduced. (Hear, hear.) He appealed to employers not to reduce wages to a beggarly level, but only to the right standard, so that they could find employment for more people. (Hear, hear.) Lord Weir had made a statement which he asked them all to follow.

Mr. L. B. Atkinson, in responding to the toast, said the country was in the greatest confusion in regard both to production and distribution. The industries had to right themselves, and the Government's part could only be a small share. We had not done with the German difficulty. People did not live on marks, but on bread. The plain fact before them was that the German people were working harder than the people of Belgium and England, and the people who would work for a unit of food would get the orders in the world's markets. They in their industry had either to adopt a brutal method of closing works or else telling their workpeople that the amount of output per hour had to rise. He impressed upon employers not to look to the Government.

The President afterwards proposed "Our Guests." The objects of their Association, he said, were essentially national and patriotic. They all recognised that our national existence and the welfare of everyone depended upon our trade prosperity. Therefore, those who left no stone unturned in their business enterprise were working in the true sense in the national cause. In coupling the name of Brig.-General Sir Henry Thornton with the toast, Lord Ampthill referred to his war service in connection with the work of the Great Eastern Railway Company. From August, 1914, to March, 1919, that company ran 13,000 special trains carrying 6,250,000 troops, 4,172 ambulance trains carrying 177,000 patients, served 203 munition works, 16 Government factories, and 31 aeroplane depôts. Forty-five factories and 16 shipyards were opened or extended, and attention was also given to the defence of the East Coast. All this work was done by the company at a time when 25 per cent. of the ordinary staff of the railway was serving with the forces. (Hear, hear.)

Brig.-General Sir H. W. Thornton, in replying to the toast, said: They in the railway world had no quarrel with the present scale of wages, provided they received from all in their service the production which corresponded with the amount paid in wages. They had no quarrel with the eight-hour day, provided they got eight hours' reasonable toil. That was all they asked. What they wanted was production. (Hear, hear.) Responsibility had a sobering effect, and there was a spirit abroad in the railway world that unless they rendered a satisfactory account of their stewardship the only alternative was nationalisation—a thing to be avoided. (Hear, hear.) He believed the time had come when labour, industries, and transport could pull together, when responsible Labour leaders were convinced that production must be increased, and that the wages paid must be commensurate with the amount of production. They must regard the present position with regard to rates as of a temporary character in order to preserve the solvency of the railways. They in the railway industry prospered only when traders prospered, so that the problem affected them both. He therefore hoped in the coming months they would be able to join hands with the great captains of industry and the responsible leaders of trades unions, and those charged with the responsibility of the administration of the new railway groups in an endeavour to restore to the country its pre-eminent industrial position. (Hear, hear.)

After the dinner, the President and a goodly number of members adjourned to the Mirror Room, where an excellent musical programme was given and much appreciated.

Scientific and Industrial Research.—The report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1920-1 is now available. It can be obtained from H.M. Stationery Office, and is priced at 1s. It contains nothing of outstanding interest.

Belfast.—Large sections of the tramway lines have been lifted in the centre of the city and the work of reconstruction is going on fairly well where it is most needed. In consequence of the political disturbances and the frequent sniping at the ex-Service men employed on the work, it is necessary to post detachments of troops to protect the workers at debatable points. The work will be spread over a couple of years at the least, so as to make the incidence of cost fall lightly at a time when the city is heavily taxed to meet the big bill of compensation which the murders and riots have accumulated.

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ROYAL AIR FORCE.

We understand that there are still a number of vacancies in the R.A.F. for qualified electrical fitters, power station engineers, stationary engine drivers, shift engineers, and dynamo and switchboard attendants. In addition, there are a few vacancies for semi-skilled electricians, who, by joining up, would get a chance to complete their training. The work is congenial, the hours regular, and the life healthy. Further, there is nothing to complain of in the rates of pay and allowances now prevailing, while security, freedom from worry, and plenty of leave are other inducements which should appeal to many trained men who, especially at the present time, are finding trade conditions none too rosy. We believe that enlistments are for 6, 7 or 8 years regular, and 6, 5 or 4 years reserve service, though in some instances enlistment is for 4 years only in the regular service.

Any of our readers interested should write to the Inspector of Recruiting, R.A.F., 4, Henrietta Street, Covent Garden, W.C.2, who will forward full particulars by return of post.

THE LOW TEMPERATURE DISTILLATION OF COAL.

The rumours current concerning German acquisition of colliery waste, shale, slack, etc., in various parts of this country should, at least, have the beneficial effect of directing public attention to this important potential source of wealth. Before the war, Germany imported large quantities of the crude by-products from British gas-works and prepared therefrom a valuable range of dye-stuffs and the bases for explosives. At that time attention was directed mainly to the possibilities of the by-products derived from the manufacture of coke and gas. During the war, the distillation products of coal were utilised in this country as never before, and many ambitious schemes of research were initiated. Promising results have been obtained, but there is still needed a widespread awakening of interest in the commercial development of various distillation processes. In the meantime—pending the awakening which must come—it is most undesirable that the rights in any of our colliery "dumps" should be alienated.

Low Temperature Plant and Products.—Both in this country and in Germany much interest has centred in the low temperature distillation of coal. Coke-oven tar and gas tar formed the bases of many industries before the war and still do so, but an entirely new field has been opened up by the production of low-temperature tar. Whereas the higher temperature distillates used in the dye industries contain aromatic hydrocarbons, the tar obtained by low-temperature distillation contains a high proportion of aliphatic hydrocarbons and resembles petroleum in its applicability to lubrication and to driving prime movers. The vital necessity for augmenting the supplies of power and lubricating oils in Germany during the war led to the development of low temperature processes for the distillation of coal on a commercial scale, and it is probable that some at least of the plant and methods evolved will be commercially useful under peace conditions.

One of the low temperature tar plants operated in Germany on a commercial scale consists of a battery of vertical rotary gas generators which supply gas for general heating purposes. Gas leaving the retorts is passed through a simple dust-trap and most of the tar is then precipitated by a tar spray before the temperature falls low enough to condense the moisture in the gases. The remainder of the tar is collected in a washing tower.

Large-Scale Installations Required.—From experience already accumulated it appears that to get maximum benefit from a low temperature distillation of coal it is necessary to keep the maximum temperature of the distillation much lower than in ordinary gas retorts. Some of the products of special interest are permanently decomposed at high temperatures and therefore cannot be obtained by fractionating the products of high temperature distillation. In determining the commercial success of a process, the capital and operating costs of the plant must be set against the market value of the products. Under normal conditions there is little or no margin in the cost of petroleum lubricants and fuel oils to allow for the costs of special coal-distilling plant yielding tar oils as its main product. The best prospects of commercial success seem to lie in developing a distillation plant capable of very accurate temperature control and suitable for the individual isolation of all the by-products then yielded. Small-scale experiments hardly afford criteria of the possibilities of large-scale plants. Nevertheless, such experiments and ordinary chemical analyses show the quantity and value of substances which may be isolated. What is required is faith in these basic results and combination on the part of the industries interested to make full-scale investigations—costly, may be, but undoubtedly profitable in the long run.

The best ways and means for the extraction of low temperature coal distillates are not yet generally known, but important announcements may be expected in the near future.* Preliminary investigations have disclosed the fact that these distillates include fuel and lubricating oils of various densities, compounds useful in varnish making and allied industries, and various grades of solid residues, such as a flaming, non-smoky coke. It will be unfortunate if these possibilities are not developed commercially in this country, and it will be still more regrettable if their development is left to foreign enterprise. There is a wider field than is generally realised for the joint operation of electricity undertakings with gas-works and coal by-product recovery installations.

"MAGNET" ELECTRIC PIPE LIGHTERS.

The "Magnet" electric pipe lighter, manufactured by the General Electric Co., Ltd., consists of a body or handle containing a push action switch and carrying at one end a porcelain cone wound with a heating coil. The cone is fitted with standard bayonet contacts and is thus easily renewable. The whole is mounted upon a neat stand with a convenient ash tray. Two patterns are supplied in several finishes and both can be quickly converted for wall mounting. It is claimed that these lighters not only offer the cleanest and most satisfactory method of lighting cigars, pipes and cigarettes, but that they are cheaper in use than matches or petrol lighters. It takes, on an average, twelve seconds to light a pipe with the "Magnet" lighter, consuming 100 watts. For an expenditure of one unit, therefore, 3,000 lighting operations can be performed. The same number of lightings with matches would entail the consumption of 60 boxes, which, at present prices, would cost 4s. 4½d. Particulars and prices of these lighters are given in an illustrated leaflet, No. H.2599, copies of which can be had on application at Magnet House, Kingsway, W.C.2, or at any of the G.E.C. provincial branches.

Concert.—On Saturday, November 12, there will be a Grand Concert held at the West Hampstead Town Hall, in order to assist the unemployed members of the North West London Branch of the Electrical Trades Union. Alderman J. I. Frazer will be in the Chair, and a splendid programme has been arranged with Mr. Philip Ritte's Concert Party. Tickets 3s. each, including tax, may be obtained from the Trades Union office, at 14, Baldwin's Garden, London, E.C.1; and in view of the object for which the concert is given, it is to be hoped that it will have a very hearty response.

* At the time these notes were written it was not permissible to refer to the splendid achievements of the low-temperature distillation plant at Baruch (nr. Barnsley). From information which we now give elsewhere concerning this plant, it will be seen that British engineers have the problem of low-temperature distillation of coal well in hand, and it is therefore more than ever important that no foreign interests should be allowed to acquire any of the raw materials concerned. The issues at stake in this industry are far greater than are generally realised.

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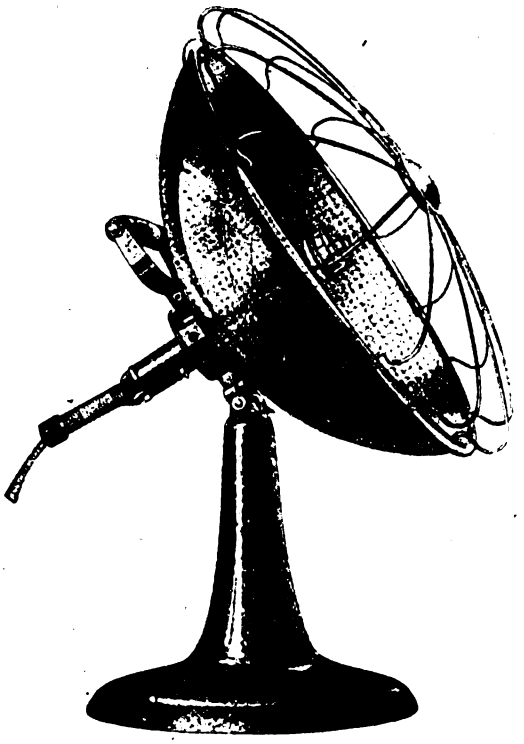
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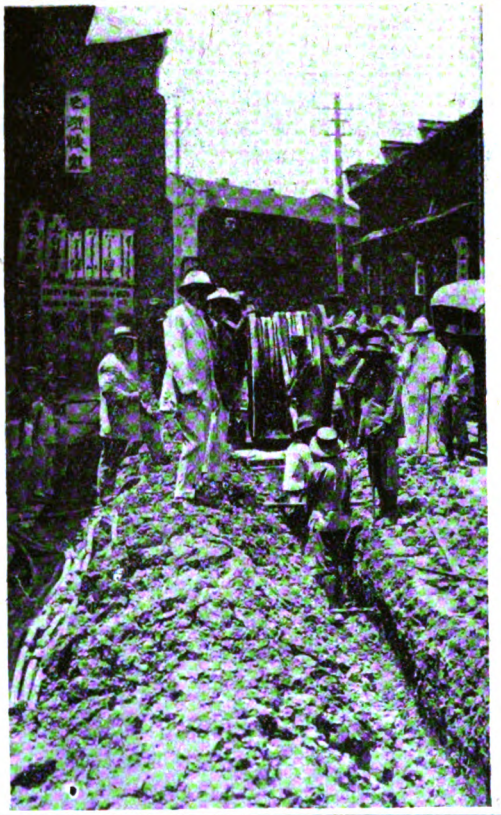
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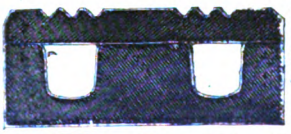
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Government Trade Scheme and Railway Electrification.

It is encouraging to learn that the Government is at last tackling the very pressing problem of getting industry on its feet again, and that considerable money grants are in prospect with this purpose in view. Among others, the allocation of twenty-five millions towards engineering and other schemes, which will provide work for many of the thousands at present unemployed, is full of promise, and it is already stated that the London Underground Railways may take advantage of the situation and seek fresh capital to the extent of eight millions for the extension of the Tube Railways under this scheme. In this connection Lord Ashfield recently told the shareholders that the directors would reconstruct the City and South London Tube as soon as £1,750,000 could be raised under reasonable conditions.

It is proposed to widen the river tunnels, bring this Tube up to the standard of the more modern lines, and create a link with the Hampstead line at Euston. It is also proposed to construct a surface line from Golder's Green to Edgware, through Hendon. This could be completed in a year. Further, a western extension of the Central London Tube from Shepherd's Bush to Richmond has been planned. In regard to other railways, there is little doubt that a considerable extension of the use of electric traction is inevitable, and the possibility of the conversion of at least the southern main lines of railway from steam to electric working is already being discussed. It is obviously desirable to secure uniformity of practice between the various companies as far as practicable, as well as to ensure the latest accepted practice in electrification development.

To this end an Advisory Committee was appointed by the Minister of Transport to report on the future of railway electrification in this country, and its final recommendations are now available. The system of generation and transmission of electrical energy to the sub-stations should be three-phase A.C., whilst power is to be supplied to the trains at 1,500 volts D.C. Either contact rail or overhead trolley wire may be used for collection of the current, and definite standard dimensions are suggested for the relative positions of rail and wire. Difficulties associated with the existence of installations already working, in which the line voltage differs from the suggested standard, have been met by recommendations that the companies concerned should be allowed to extend their lines subject to Government approval. All these preliminaries spell a recrudescence of prosperity for the electric traction industry and those engineering firms which cater for the requirements of electric railway operation and construction.

Electric Cooking for Railway Diners.

Whilst on the subject of railways, it is interesting to record the recent success of the Great Northern Railway Company in the application of electric cooking to the preparation of hot meals on its main line express dining-cars. For nearly a month past this modern system of cooking has been on practical trial on the 10.10 express from King's Cross to Leeds. So far the experiment has proved highly successful, and not only has the risk attendant upon train gas cookery been abolished, but, in the event of an accident to the electrically equipped travelling kitchen, current is automatically disconnected. Current is derived in the usual way from dynamos driven by the train itself, and the installation of ranges, etc., is thorough and complete, enabling the most diverse menus to be presented to hungry travellers by this route.

Panic Legislation.

An interesting sidelight on the rough and ready manner in which new legislation is introduced and put into immediate operation without careful analysis of the probable consequences and lacking considered details in the manner of its application, is furnished by the recently reported results of the Safeguarding of Industries Act. Under this Act certain basic materials coming into the country are taxed with a view primarily to safeguard British industries which are concerned with the production of similar materials. In their zeal the Customs authorities have sought to apply their newly conferred powers under this Act to the exploitation of certain manufactured goods containing a small percentage of the materials dutiable, on the ground that the Act may be held to apply in such cases also.

There have been farcical hold-ups of pocket torch batteries because they contained small carbon electrodes which might be interpreted as coming under the description of arc lamp carbons, whilst finished electric incandescent bulbs have also been delayed and the importers put to considerable expense and delay because the filaments contained tungsten of negligible quantity. It is the old story of the police and the Motor-car Acts over again; legislation is framed by a combination of legal minds without due regard to the average intelligence of the minor officials who will have to administer the law when it becomes part of the Statute Book. The ultimate result is invariably ludicrous and irritating both to the public and the trader. What appears to be sadly lacking at Westminster is a series of technical editing committees with practical experience of the various interests involved in every new Act, through whose capable hands these Acts could be passed for amendment and general correction and correlation of detail.

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High-voltage Repair and Maintenance Work.

In this country the man in the street often regards with amazement the indifference with which the electric tramway maintenance gangs handle overhead live trolley wires and effect repairs from the high platform of a travelling tower wagon without unduly interrupting the traffic. This occupation, however, is child's play by comparison with the activities of what is known as "hot" line maintenance in the States, where repairs are carried out, insulators removed and replaced, and all necessary changes effected on overhead transmission lines operating at anything up to 33,000 volts.

Whilst engaged on this apparently perilous work the men stand on stagings or ladders of specially treated hardwood, capable of withstanding 100,000 volts per linear foot. The staging or ladder (sometimes both if the job is complicated) is secured to the pole by special fastening devices in such a position as to enable the man to conveniently reach his work. Guards also made of treated wood are placed to prevent accidental contact with guys, cross-arms, or a phase other than that upon which work is in progress. When the man enters the staging he is thus completely insulated, and may touch the "hot" line without experiencing any sensation other than a slight static "zip" as he makes and breaks contact.

The Beama Dinner.

On another page my readers will find an account of this very successful function, and I am sure that all who were present agreed with the sound businesslike tenor of the few speeches which were made, particularly the remarks by Mr. Ll. B. Atkinson, the outgoing president of the I.E.E., but I am always wishing that these sound, common-sense speeches dealing with such hard facts could be listened to by a certain number of shop stewards, foremen and other trade unionists, who have so much to do with the output from our great factories. If only they can be brought to see the utter fallacy of the "ca' canny" system, and that, instead of making more work for their mates, it actually reduces it, I think some of the more level-headed men would want to kick out the hot-heads and gasbags, who have done so much harm to Old England during recent years. That is my view. Bring those workmen among us more. Don't let them think they are a class apart. I am certain such fraternisation would benefit all parties in the long run. We have all got to hang together, so to speak.

ELEKTRON.

A.A.—The 1921 edition of the A.A. and M.U. Handbook (Whitcomb Street, Coventry Street, W.C.2) contains an attractively and clearly written section on "Motor Law," all the new regulations appertaining to the use of motor vehicles being concisely detailed and explained. The A.A. roadside telephones, which have for the last six or seven years been widely appreciated by motorists, are now fitted with exterior lights for indicating their whereabouts to members travelling after dark; keys issued to members enable them to use the 'phones at any time of the day or night. Every motorist ought to belong to such a society as the A.A. and M.U. Under present conditions the A.A. Handbook (with its long list of recommended and graded hotels) is issued free to every new member. Revised editions, when published, are available on payment of 3s. each.

THE E.L.M.A. PUBLICITY CAMPAIGN.

One of the most conspicuous features in recent electrical history is the growth of the association movement. Every important section of the industry now has its representative body, and to an increasing degree the machinery of production and trade operates through incorporated associations, whose prime function is to protect the common interests of their members, but to this elementary purpose they have added many others of no less value—the establishment of standards of quality, the encouragement of joint research, the equitable control of trade relations, and the promotion of electrical progress.

The Electrical Lamp Manufacturers' Assocn., for example, concerns itself not only with the efficiency and reliability of lamps and the stabilisation of prices, it acts also as a direct stimulus to the spread of electric lighting. The publicity work undertaken by individual lamp firms had an indirect effect upon the general popularity of electric lighting, and its success led the Assocn. to attempt, two years ago, to supplement it by a combined effort to set forth, not the advantages of any particular lamp, but the broad advantages of electric light and of the lamps which bear the hall-mark of the Assocn. The results were so far promising that the Assocn. has arranged for another national publicity campaign during the season upon which we have now entered.

This campaign has two phases. One is to arrest the attention of the world and his wife, and to create a livelier demand for electric light and E.L.M.A. lamps in the home, the office, the factory, and the public buildings. The second is to invite the active co-operation of the electrical trade. In pursuit of the first phase the newspaper and general Press is being utilised; and for the second the trade and technical journals form the first line of approach. Series of advertisements have been arranged in London daily and evening papers, and in provincial daily and weekly newspapers. These advertisements will be supported by others in the weekly and monthly illustrated journals and magazines, thus ensuring a continuous and manifold appeal to the general reader on behalf of electric light as afforded by E.L.M.A. lamps. The business man and the trade user will be addressed through the specialist Press, covering engineering industries, mines and collieries, textiles and soft goods, the catering and provision trades, shipping and shipbuilding, railways, breweries, building, ironmongery and hardware, and many others. The type of advertisement will, of course, be adapted to the class of user reached by each medium of publicity.

A well organised campaign on such an extensive scale must lead to a material increase in the demand for E.L.M.A. lamps, which demand it is important the wholesale and retail electrical trade should be ready to satisfy immediately it arises. In creating business for itself the Assocn. creates it for every member of the lamp trade. This is the main argument for energetic co-operation by the wholesaler and retailer during the progress of the campaign, but publicity work such as the E.L.M.A. is undertaking has much more extensive results, as increased sales of lamps bring an augmented demand for reflectors and fittings, for numerous accessories, and for installation work in general. *Every user of electric lamps is a potential buyer of other current-consuming appliances.*

Details of the E.L.M.A. advertising campaign and some general notes on the Assocn. are contained in a most attractively designed and produced booklet which has been got out by the Scheff Publicity Organisation, Ltd. (125, Pall Mall, S.W.). Examples of the advertisements and a list of the papers in which they are appearing are given, while, in a large coloured map of the British Isles, the population and numbers of users of electric light and gas are given for the principal counties—an arrangement which clearly shows at a glance how desirable well thought-out propaganda

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work still is on behalf of that agent of Light, *Electricity*, among the poorly educated masses. The pioneer British electric lamps are embraced by the E.L.M.A. Their names are Cosmos, Elasta, Foster, Mazda, Osram, Royal Ediswan, Siemens Britannia, Stearn, and "Z."

HIGGS BROS.' MOTORS AND DYNAMOS.

D.C. motors and dynamos up to about 60 h.p. are comprised in the standard manufactures of Higgs Bros. (Sand Pits, Birmingham), who a few years ago also turned their attention to producing A.C. motors of the same high standard as regards neatness, strength, reliability and efficiency. All machines are made to the British Standardisation Rules for Electrical Machinery (Report No. 72/1917).

All D.C. machines are of the "protected" type, see Fig. 1, and among the points of note we would mention that the field coils are wound with enamelled wire and are connected together by copper strip. The armature (Fig. 2) is fitted with the Higgs fan (Patent No. 120320) directly mounted

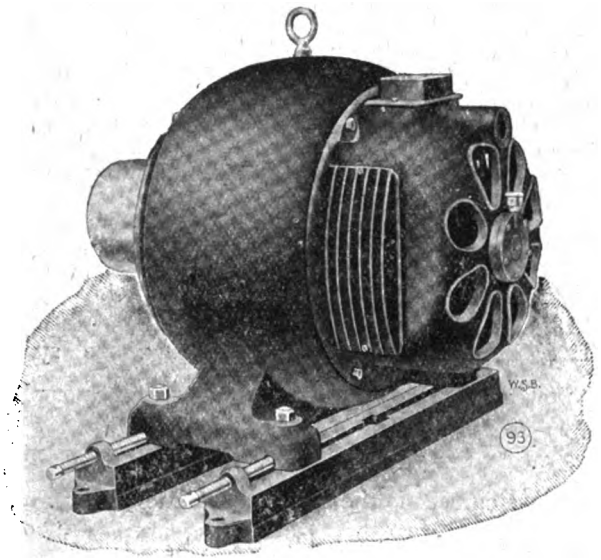


FIG. 1

on the winding cup, which is easily removable. The end covers are massively constructed of cast-iron. The sliding box type brass brush holders are carried on spindles which are held in the cast-iron rocker by means of a draw-in collet. This collet in turn clamps an insulating bush, which

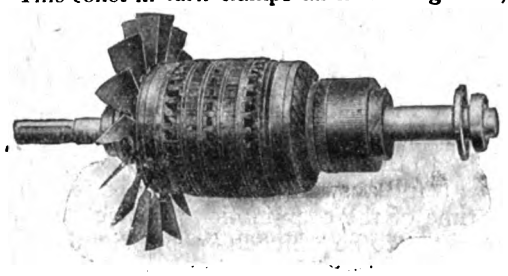


FIG. 2.

is manufactured with specially prepared paper which will not shrink, and by this arrangement tight brush spindles are always ensured. On the smaller machines the same type of insulation is used, but the spindles are built in the rocker by the usual clamping method. Ball or roller bearings are fitted throughout—the same size bearing is fitted at both ends. All D.C. machines are reversible under full load with the rocker in the neutral position, and with rocker adjustment can be used as variable speed motors up to a maximum of one to two. Standard machines are shunt wound, but series or compound windings are provided to order. Interpoles are fitted in all except the smaller sizes of machine.

A feature of all the standard machines is that the windings are such that they can be used in tropical climates and humid atmospheres. A useful box of spares is sent with each machine.

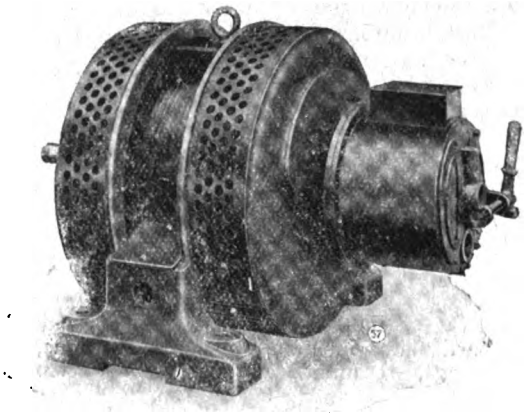


FIG. 3.

The A.C. motors are of the induction type, and have either wound or squirrel cage rotors (Fig. 3 shows the wound rotor type). For cooling, a centrifugal fan running outside the stator winding and carried on the rotor shaft is fitted. The air enters through one perforated band, travels through the rotor core and exhausts through the other end. The construction is protected by patent (No.

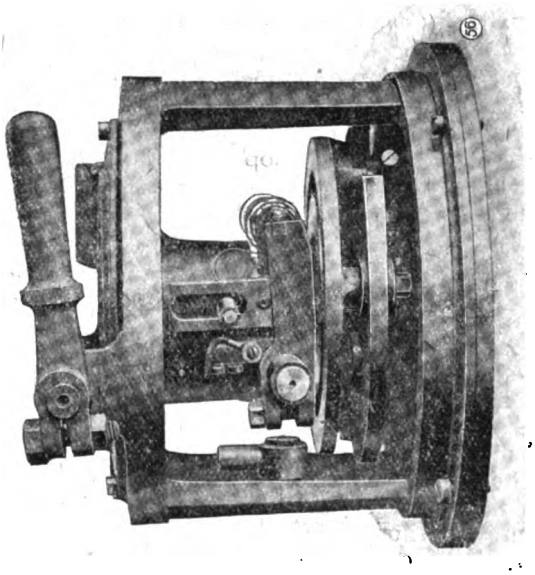


FIG. 4.

121399). All the wound rotor machines are fitted with a patented (No. 132362) short-circuiting and brush-lifting device in which, as the slip rings are in the vertical plane (see Fig. 4), a simple construction is possible, and, at the same time, both operations are effected by motion rods in the same plane.

The squirrel cage rotor is also the subject of a patent (No. 150579). It will be seen by reference to Fig. 5 that copper bars of rectangular section are inserted in semi-

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closed slots, and the ends are twisted through an angle of 90 degrees. They are so proportioned that they now touch one another, and, after being welded together, form a solid short-circuiting ring, the finished article being an indestructible rotor.

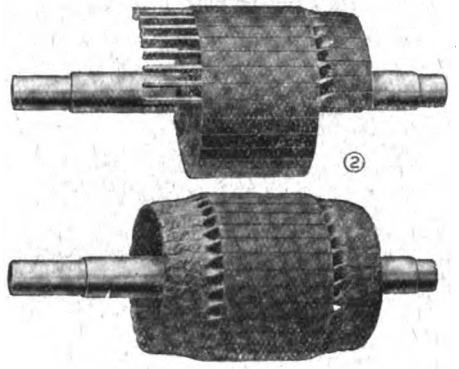


FIG. 5.

Fuller particulars, including many illustrations, dimensions, drawings, recommended control-gear, connections, particulars of tests, etc., are included in a new publication called "Electric Motor Specification No. 7."

Higgs Bros. also mount any of the machines on bed-plates to form motor-generator sets, boosters, balancers, etc.

ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to Questions set at the 1921 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page* 558.)

Q. 5.—Describe a method whereby a single alternator with a large number of poles can be tested with normal current in both stator and rotor windings when only the losses are supplied to the machine.

A. 5.—When an alternator has a large number of poles, the most economical method of testing the machine is to reverse the polarity of *alternate pairs* of poles, and to connect the coils on the unreversed poles in series to form one circuit, whilst the remaining coils are joined in series to form another circuit. Thus, if an alternator has eight poles, the coils on poles 1, 2, 5 and 6 are joined in series, whilst the coils on 3, 4, 7 and 8 are also joined in series with one another but their polarity is reversed. If the number of pairs of poles on the alternator be an even number, and if equal currents be sent through the two sets of exciting coils, the e.m.f.s induced in the various coils of each phase neutralise each other; consequently, if the armature be short-circuited, no current flows.

Now, if the current in one of the field circuits be increased whilst that in the other be decreased, the e.m.f.s will no longer neutralise each other, and a resultant voltage will be available to circulate a current round the short-circuited stator winding; and by varying the exciting currents, the circulating current can be adjusted to the full-load value. If the field be—as usual—of the revolving type with two slip-rings, the difference between the two exciting currents is obtained by inserting a resistance between a slip-ring and the coils of one circuit, and securing this resistance to the rotating part of the machine.

Since the alternator is on short-circuit, all the input to the machine is dissipated as losses. If the average exciting current be about the normal field current of the alternator, the flux will be practically at its normal value, so that the iron losses may also be taken as being at their normal value, though the altered condition due to adjacent poles of similar polarity will modify these losses to some extent. This method, however, gives more satisfactory results than any of the other methods that have been suggested from time to time for the testing of alternators with the expenditure of the minimum of power.

(*To be continued.*)

Correspondence.

To the Editor of ELECTRICITY.

DEAR SIR,—"Interested" inquires about the derivation of an expression appearing in the answer to *Q.* 4 of the C. and G. Questions (ELECTRICITY, Oct 7 issue). Unfortunately, owing to the high cost of paper and of printing, one has sometimes to compromise between detailed explanation and the assumption of a good knowledge on the part of the reader.

With reference to column A of the first table on page 557, it will be noted that v is the maximum voltage of one half of the phase—the mid-point being earthed; so that the maximum voltage across the line conductors of that phase is $2v$, and the effective value of this voltage is $\frac{2v}{\sqrt{2}} = \sqrt{2}\,v$.

If P be the total power for the 2-phase system the power per phase is $\frac{P}{2}$, so that the current per phase is $\frac{P}{2} \div \sqrt{2}\,v = \frac{P}{2\sqrt{2}\,v}$; but for a 2-phase 4-wire system, the phase current is the same as the line current.

The resistance of each line can be expressed as $\frac{k}{A_1}$, where A_1 is the sectional area of the conductor; consequently the I^2R loss per line is $\left(\frac{P}{2\sqrt{2}\,v}\right)^2 \times \frac{k}{A_1}$ $= \frac{1}{8}\left(\frac{P}{v}\right)^2 \frac{k}{A_1}$. There are four line conductors, so that the total line loss is $4 \times \frac{1}{8}\left(\frac{P}{v}\right)^2 \frac{k}{A_1} = \frac{1}{2}\left(\frac{P}{v}\right)^2 \frac{k}{A_1}$.

The same argument applies to the other columns; so I trust that this explanation will clear up "Interested's" difficulties.

In reply to the second query, I must candidly admit that such a full answer would hardly be feasible in the limited time of the examination; in fact, the answers are not meant to be "Models"—but simply to explain as completely as possible within reasonable space limits the problems raised by the various questions.

Yours truly,

EDWARD HUGHES.

Technical College, Brighton,
October 21, 1921.

JOHN E. RAWORTH & MOSS,
75, Victoria Street, WESTMINSTER. S.W.1. Chartered Patents Agents.

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"COSMOS" RADIANT FIRES.

To the Editor of ELECTRICITY.

DEAR SIR,—We are pleased to observe in your current issue, under the head of "Trade Notes," your remarks in respect of our "Cosmos" Radiant Fire showcard, and to learn that you consider this publication to be effective and pleasing.

We are not, however, in entire agreement with your observation regarding the use of Radiant Fires in nurseries. We are ready to admit that it would not be advisable to give children a Radiant Fire or any other type of electrical apparatus with the current switched on, and allow them to use it as a plaything. Consequently, if children are left alone, the Radiant Fire would have to be placed out of their reach, such as in a high position or behind a fixed guard.

There is no doubt that the heat emanating from a coal fire in the form of radiant heat is much more hygienic than heat produced by means of convectors of any kind, and this reason we think is alone sufficient to justify the use of a Radiant Heater, which, unlike a coal fire, is not associated with fumes and smoke.

Furthermore, it is difficult to conceive any better method of providing the luxurious cosy glow for baby's bath, which is so readily obtained by means of an Electric Radiant Fire.

We would like to have your further remarks on this theme.

Thanking you for the publicity afforded,

We remain, yours faithfully,

Metropolitan-Vickers Electrical Co., Ltd.,

E. C. W.,

Publicity Department.

20, Brazennose Street,
Manchester.

October 24, 1921.

GAS *v.* ELECTRICITY.

To the Editor of ELECTRICITY.

DEAR SIR,—We should be very pleased if any of your readers could supply us with information concerning the cost of running gas-heated furnaces for the heat-treatment of steel.

What we desire to know is what the number of cubic feet of gas amounts to per pound of steel treated.

We have already some information upon this point, and so far have found that the cost of gas heating invariably exceeds the cost of heating by electricity.

There may be, however, on the market, a gas furnace more economical than any that we have yet met with, in which case we should like to hear of it.

Yours faithfully,

E. P. BARFIELD,
Managing Director.

Automatic and Electric Furnaces, Ltd.
October 21, 1921.

Trade Notes.

E.D.A. folder No. 196 is an attractive and inexpensive production which contractors, dealers in electric fires, and supply authorities could with advantage enclose with accounts, invoices, etc., as the education of the consumer in the advantages of the electric fire would thus be increased and in many cases business would result. The leaflet can be obtained (overprinted if desired) from the **Electrical Development Association** (84, Kingsway, W.C.2).

A large selection of all-steel tubular barrows for all industrial purposes is to be found in List No. 151, issued by **H. C. Slingsby** (42-6, Old Street, E.C.1). They are excellently designed for taking apart so as to occupy a minimum space for transport.

Users of electrical power who are not already under agreement to have their equipment periodically inspected and reported on, would be well advised to investigate the system of fortnightly inspection maintenance and insurance of dynamos, motors, lifts and other electrical plant effected by the firm of **Marryat & Place** (28, Hatton Garden, E.C.1). Readers will know that the firm are specialists in armature repairs. We might also remind them that M. and P. are very much alive with regard to installing lighting, telephones, motors, lifts, cranes, etc.

For the use of Supply Authorities, contractors and dealers, the **G.E.C.** have produced a booklet entitled "Just Switch On—That's All." It is intended by its distribution to arouse the interest of users of electric light in the possibilities and advantages of electricity for heating and cooking. Notes are given on the calculation of cost of use as well as some hints on electric lighting. Page 2 of the cover is left blank, and the **G.E.C.** will print thereon, free of charge, particulars of the local supply charges, etc. Application should be made to Magnet House, Kingsway, W.C.2, or to any of the Company's provincial branches.

Siemens Bros. & Co., Ltd. (Woolwich, S.E.18), have issued an illustrated brochure dealing with the lighting of Covent Garden Markets. "Stannos" Wiring was largely used. In another publication a list of a number of residences in which "Stannos" has recently been installed is given.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 126.

What are the essential principles to be observed when designing electro-magnetic relays to ensure quick action? I desire to design a relay with 1-100th second period of contact. This is to operate on 12 volts, being connected to this supply through leads having a resistance of 3 ohms. The circuit closed will carry 15 amperes at 40 volts. I would like details of a suitable design with a method of verifying the accuracy of the relay to operate in the period stated. I would also appreciate the name of a technical book or paper from which I can obtain details of designs of this nature.—"B."

QUESTION No. 127.

I desire to have electric light and electric motors fitted in my boot factory. I would like you to point out the most essential features to be considered when drawing up a specification to enable the correct type of motor and fittings to be installed. The supply is 500 volts, three wire.—"Astatic."

(Replies to Questions Nos. 126 and 127 must be received not later than October 29, 1921.)

S.W. Midlands Electricity District.—The Local Inquiry by the Commissioners into this proposed District will be held on November 15 in the Council Chamber, Birmingham. Included in the Agenda is the consideration of (a) the joint scheme proposed by the Birmingham Corporation and the Shropshire, Worcestershire and Staffordshire E.P. Company, and (b) the preliminary scheme of the Worcester Corporation relating to Worcester City and parts of the county.

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SUBMERSIBLE ELECTRIC MOTORS FOR MINE'S PUMPS.*

By A. J. Ramsay.

(*Continued from page* 587.)

The conductors are of circular cable, built up of a large number of finely-stranded and tinned-copper wires, insulated with a special preparation of india-rubber. The lays of the strands are so arranged as to give a minimum diameter for a given cross-sectional area, and to make possible an easy and safe bend on the overhang. By this means there is complete continuity of insulation throughout each phase of the winding. The star point is carefully spliced and vulcanised in a special mould. In this type of machine the free ends of each phase are brought out through a stuffing-box on the motor-frame for a length of about 50 ft., and there terminate in a three-pole watertight coupling. The extended cables are protected by armoured rubber hose. The overhangs of the coils are clamped securely to the motor-body. The iron core-plates of both stator and rotor are treated with a special varnish, each plate being passed through a machine resembling a domestic mangle, the rollers of which revolve in the liquid. By this means an even layer of varnish of minimum thickness is applied to each plate, thus effectively sealing the joints in the assembled core.

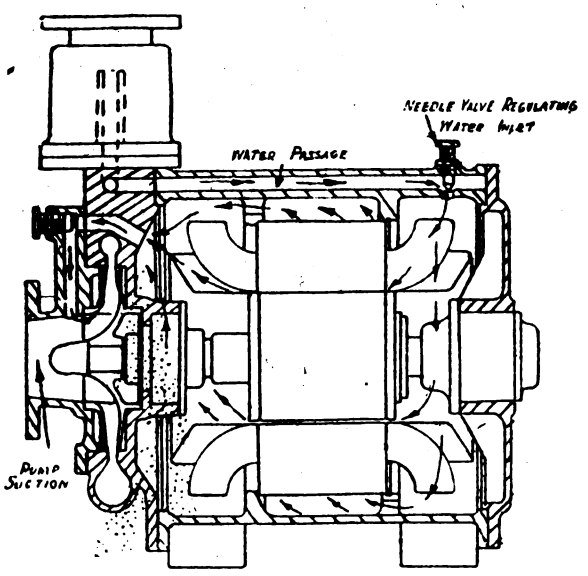


Fig. 1.—Motor Pump, Showing Water Circulation.

The water-channel within the volute casing is of standard design, with gradually increasing sectional areas in the direction of rotation of the impeller. The boundary line of the volute is such that it conforms to the actual angle of discharge of the water from the impeller. A filter body is attached to the discharge flange, and into the centre of this body is fitted a brass cylinder, the inside diameter of which is equal to the diameter of the discharge pipe. The function of this filter will be described later.

Cooling-Water Circulation.

In Fig. 1 the arrows indicate the paths taken by the water from the pump to the motor and back to the pump. The water in this type of pump is taken from the filter previously mentioned, which is mounted on the pump discharge. The brass cylinder through which the water passes is provided with a large number of openings about ⅛ in. in length circumferentially and about 20 millimetres (0.8 in.) in width axially. These openings lead into an annular chamber of ample dimensions surrounding the brass cylinder, in which chamber the water moves at a very low velocity.

For this size of machine 10 gallons per minute are quite sufficient for perfect cooling of the motor, which represents, say, 1.33 per cent. of the total quantity delivered by the pump. The water passes from the filter body through cored passages along the top of the motor body, and passes to the interior of the motor through a hole, the area of which can be regulated by the adjustable needle-valve shown. Within the motor the water may take several paths. Some passes through the air-gap, a larger quantity passes through the annular chamber between the core-plates and the motor body, and a further path lies between the conductors from end to end of the slots in the stator core. The water finally passes through connecting passages into the pump suction, the area of opening in the suction being again controlled by an adjustable needle-valve.

From the foregoing description it will be seen that the modern machine differs from the original in one very important respect, namely, that whether the machine be above or below water, the motor always receives a positive supply of cooling water. The roller and thrust bearings, which are mounted in gun-metal housings filled with grease for lubricant, are practically surrounded by water at all times, and are therefore prevented from heating.

(*To be continued.*)

*Abstract of paper read before the North Staffordshire Inst. of Mining Engineers and first published in *The Mining Electrical Engineer.*

Various Items.

Electric Railways in Norway.—Work will soon be started on electric railways from Christiania to Ostensjo and from Majorsteum to Sognsvandet.

Meetings.—The Inst. E.E. will meet in the Lecture Theatre of the Institution, at Savoy Place, Victoria Embankment, W.C.2, on Thursday, November 3, at 6 p.m., when the inaugural address will be given by Mr. J. S. Highfield, president, followed by the Presentation of Premiums.

Personal.—Two of George Ellison's employees, Messrs, Smith and Spate, have been selected to represent the Birmingham and Districts Works Amateur Football Association in their match against the Victoria League on November 5. Mr. Smith will captain the team.

Drake and Gorham.—The 20th annual general meeting was held yesterday. The report shows that after payment of all charges a net profit of £13,433 remains on the year's trading to June 30. Of this 6 per cent. is being paid on the Ordinary shares (accounting for £7,500), £5,000 goes to writing down goodwill, £7,400 to reserve for E.P.D. and C.P.T., leaving a carry forward of £5,768, against £12,235 last year.

Blackburn.—The new electricity generating station at Whitebirk was formerly opened on Friday by Lord Derby, who started the 18,000 h.p. turbine. Afterwards Sir Charles Ellis (chairman of the English Electric Co.) presented Lord Derby with a silver casket on behalf of the contractors. Among those present were Mr. P. P. Wheelwright (Blackburn's electrical engineer), after whose design the construction and arrangement of the works were carried out; Sir Chas. Ellis, G.B.E., K.C.B. and Mr. P. J. Pybus, managing director, representing the English Electric Co.

Meetings.—The Junior Inst. of Engineers will meet on Friday 28th inst., at 8 p.m., Lecturette, "Water Gas Manufacture," by F. Colin Sutton (Member). Slides. Also on Friday, 4th November at 8 p.m., Lecturette "Timber Trees of Commerce," by T. H. Ivey (delivered by W. Ivey (Member). Both meetings at Caxton Hall.——The Forthcoming meetings of the I.E.E. are as follows:—Ordinary meetings, 6 p.m.' 3rd November, J.S. Highfield (President). Inaugural Address, and 17th November, E. S. Byng, "Telephone Line Work in the United States." A Wireless Sectional meeting will be held 6 p.m. on the 9th November, when Dr. G. W. O. Howe (Chairman of the Wireless Section) will give an Address.; and an Informal meeting will be held 7 p.m. on the 7th November. Discussion on "How best to speed up Electrical Progress" (opened by Mr. J. S. Highfield, President).

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
NOVEMBER 4, 1921.

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TRADE IN CANADA.

In the valuable reports on the conditions and prospects of British trade in the different countries of the world, which are published annually by H.M. Stationery Office, items of interest and value to manufacturers and traders are continually to be found, and it is to be hoped that the expert information and advice collected by H.M. Trade Commissioners or Commercial Secretaries are studied and acted on. A particularly valuable report from among those recently issued is, in our opinion, that prepared by Capt. E. J. Edwards on Canada (H.M. Stationery Office, 2s. 3d. net).

Canada is a vast market with unlimited possibilities for the British manufacturer if it is nursed in the right spirit. We shall therefore make a few extracts from the report.

Advertising.—"The two main points in regard to advertising which I wish to drive home to U.K. manufacturers who already have a market in Canada, or are seeking to develop one, is that they should do more advertising, and that they should do suitable advertising.

"Though there is a growing tendency among U.K. manufacturers to admit that a certain amount of advertising is necessary, comparatively few of them go about it in the right way. In some cases they stipulate that their Canadian agents must do the advertising themselves out of their commission, while in other cases agents are informed that an extra percentage will be allowed them to expend on advertising after their sales have reached a certain amount. There is overwhelming proof that both these methods are wrong, and that the manufacturer himself must do the advertising. I think there are comparatively few U.K. manufacturers who would adopt either of the above methods with their home travellers or representatives, and the arguments which would negative such procedure in the one case are equally applicable to Canada.

"While I have stated that the advertising must be done by the U.K. manufacturer, it is comparatively useless for him to do this without the assistance of someone who can give disinterested and expert advice on the "matter" and "lay-out" of the copy, and also the media to be employed. It is a great mistake to imagine that advertising copy which has been proved to have had a pulling power in England will have the same success in Canada, and while many manufacturers have successfully used the same scheme in Canada as they have in England, and even in some cases the same blocks, the copy has been altered and adapted to suit the market.

"Unless the U.K. manufacturer has on his advertising staff someone with an intimate, personal knowledge of Canada, or else is satisfied that the advertising agent whom he employs is so equipped, it is probably desirable for him to entrust his advertising to one or other of the Canadian advertising agencies of repute, for these latter are not only able to frame up a good advertisement, but it is their business to know which papers will produce the best results for the particular article advertised.

"The majority of the poster hoardings in the more important cities are of uniform size and are so arranged that they take mammoth posters, each having a solus position. Most of these are brilliantly lighted until after midnight."

Engineering Machinery.—"During the year ending March 31st, 1921, the total machinery imported into Canada, excluding agricultural, amounted in value to $44,642,000, of which no less than $40,767,000 represented importations from the U.S.A., while the U.K. was responsible only for $3,546,000. Although the last-mentioned figures are more than double those of the preceding year they are anything but satisfactory, especially as during that period U.S.A. trade increased by six and a half million dollars. At the time of writing few orders are being placed for machinery, and there is little likelihood of any improvement in the immediate future. This is brought about by the period of depression through which Canada, in common with the rest of the world, is passing, and also because buyers are hoping that prices will still further decline.

"It is impossible to write in detail regarding the prospects for all the various classes of machinery, so I will confine myself to general remarks which may be applicable to all. In the majority of cases tenders and delivery are required in a hurry. For instance, a town may have been perfectly contented with its existing water supply until at one meeting of the council it is proposed and carried that a new plant be installed. Tenders are called for immediately, and the question of delivery is a predominant factor. Naturally, U.S.A. engineering firms benefit by this Canadian characteristic, and this brings me to my second point.

"There is seldom sufficient time for blue prints or specifications to be obtained and sent home so that U.K. manufacturers may tender. Consequently adequate local representation is essential, either by branch houses or by agents. I use the word 'adequate' purposely, for I consider it imperative that the agents should be really technical men with an expert knowledge of the various types of machinery which they are trying to sell and the uses to which these are put. They should be so qualified that where there is not sufficient time to mail particulars to their U.K. principals, they are able to put the salient points succinctly in a cable. I would urge United Kingdom engineering firms when replying to a Canadian inquiry to remember the proximity of the U.S., and therefore to quote their very lowest prices and to give the most forward delivery date possible, which must be rigidly adhered to should the order eventuate.

"It would certainly be of benefit if H.M. Trade Commissioners in Canada were kept supplied with illustrative and descriptive catalogues of all classes of machinery and engineering work. Only this week a visitor to my office stated that he would have to order certain equipment from the U.S.A. because he felt sure that no firm in the U.K. could produce the exact type he wished. I told him the name of three makers who I believe could satisfy his requirements, and offered to cable, but he informed me that this would take up too much time and it would be difficult to give sufficient details by wire. By an extraordinary coincidence, on the same day a well illustrated catalogue arrived from one of the three firms which I had mentioned, and in it was depicted exactly the class and type of machine for which the inquiry called. The matter is not yet settled, but I quite hope an order for the U.K. will result.

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"Another important point which prevents orders from going to the U.K. is the difficulty and expense in obtaining spares and replacements.

"It may not be out of place for me to comment upon the fact that Canada's engineering and machinery requirements are considerably in excess of what might be imagined from her population. In proof of the above the following figures regarding certain industries may be of interest. In each case they are for twelve months and are the latest available:—

	$
Mineral Products	217,000,000
Forest Products	146,333,000
Manufacturing Exports	403,132,000
Water Power Development ...	2,418,000

"This last amount is only about 12 per cent. of Canada's available water power.

"At a rough estimate 700,000 hands are engaged in manufacture, and much of the machinery and equipment required in the works where they are employed is not made in the Dominion, but has to be imported."

GENERAL.

The following items of general interest should also be noted:—"Commercial conditions appear to be in a transitional stage leading to steady and progressive prosperity." Also "on and after Dec. 31st, 1921, all goods imported into Canada capable of being marked, stamped, branded or labelled, without injury, are to be so marked in legible English or French words in a conspicuous place that shall not be covered or obscured by any subsequent attachments or arrangements, so as to indicate the country of origin. Such marking shall be as nearly indelible and permanent as the nature of the goods will permit. If any goods are imported into Canada after Dec. 31st, 1921, without being marked with the country of origin, they will be subject to an additional duty of 10 per cent. *ad valorem*, and also will not be released from customs possession until they have been properly marked under customs supervision at the expense of the importer. The advantages of this enactment are great and obvious, and no part of the world will receive more benefit thereby than the U.K. Just to give two illustrations—cutlery manufactured in Sheffield, U.S.A., and cotton goods made in Manchester, U.S.A., will now have to be marked with the words 'Made in the U.S.A.' and the possibility of misapprehension as to the actual country of origin will be removed."

Other recent reports deal with that peculiar country, Japan, and with New Zealand, and East Africa (Uganda Protectorate, Kenya Colony, Tanganyika Territory and Zanzibar).

PRODUCTIVE RELIEF WORK.

Among the various proposed measures for the relief of unemployment and stimulation of trade, Parliament will vote a certain sum to be applied, under necessary conditions, for financing the schemes of public utility, which obviously is better than a continual payment of doles. The whole subject is, however, so complex that the daily and weekly newspapers appear to be able to go on filling columns and columns, and some of the "labour leaders" to go on spouting and spouting for ever. We have been very pleased to note that important schemes of extension of the tubes in London are ready to be carried out if the necessary capital be forthcoming. As soon as it is mooted, however, up comes the L.C.C. debating the possibility of constructing "tubes" itself, as well as of improving the tramway system. The desirability of the latter is doubtful, but probably as the big town tramway is now obsolescent, the less done with the L.C.C. trams the better. On the other hand, being faced with its colossal losses on trams, it is at least curious that even a section of the L.C.C. should wish to embark on tube railways, and while admitting that the extensions are badly wanted, we must record our opinion that the L.C.C. is not the body to do it. We are glad that the motion was lost at Tuesday's meeting.

Apropos of relief works, there is an editorial in the latest issue of the *English Electric Journal* in which it is pointed out that the loss to the nation through ordinary relief work, *i.e.*, the digging of reservoirs, the making of parks, or of maintenance divorced from work, is not always realised.

Take a man earning £4 a week in an engineering shop and transferred through lack of employment to relief work at the same wage. His normal employer has a clear loss, in unabsorbed establishment charges, of £5 a week, on the moderate basis of establishment charges of 125 per cent. on labour. On relief work a good tradesman is inefficient and uninterested, and of the £4 a week which he is paid probably not more than £1 on the average has any permanent value. There is, therefore, a loss to the nation of £8 a week through this one man being turned adrift from his normal employment. An electric power station, on the other hand, or the electrification of a railway absorbs an enormous amount of direct labour per £ expended, and it is an important addition to the wealth and the wealth-producing capacity of the country. An examination of an actual railway electrification scheme, which would cost £6,000,000, and, under normal good management, could not fail to produce a fair return on the money spent, shows that when every allowance is made for certain imported materials, such as copper, £4,800,000 out of the total capital cost of six millions would be spent on direct labour in this country. Nearly all the great railway companies have schemes for electrification worked out or in contemplation, but it is unreasonable to expect that the large sums of money required can be raised unless the status of this new money in relation to the present capital of the railways is safeguarded. If the Government would trust the great industries of the country by facilitating the financing of such schemes, a large number of men could be found employment at their own trades, instead of being left to the slow demoralisation of the dole or useless relief work.

JUGGLING WITH COLOUR.

A NEW METHOD OF SHOP WINDOW LIGHTING.

By means of a new simple B.T.-H. X-Colour-Ray attachment, consisting of frame, slide and colour medium, striking and distinctive colour effects can be obtained in

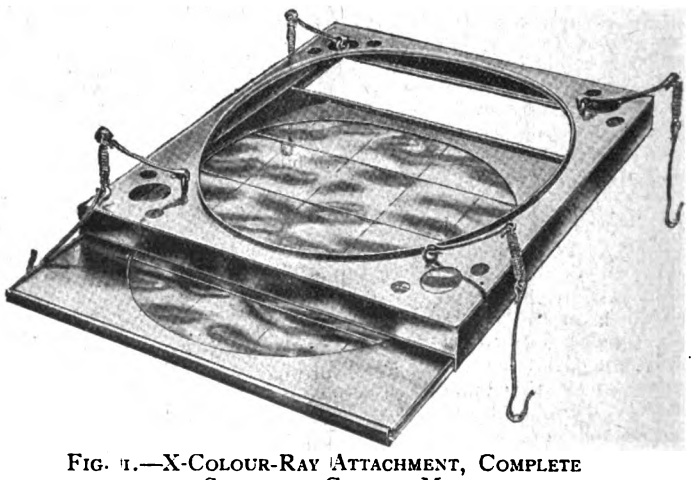


FIG. 1.—X-COLOUR-RAY ATTACHMENT, COMPLETE WITH SLIDE AND COLOUR MEDIUM.

the lighting of window displays. The frame fits over a "Jove" or "Jupiter" X-Ray reflector, and is attached to the reflector by means of four hooks which fix in the ventilation holes. The slide is made to hold the gelatine colour

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medium (the only medium that does not rapidly fade), supporting it by means of fine steel wires. Red, amber, blue and green are the standard colours provided.

An important feature of the X-Colour-Ray attachment is that the colour of the lighting can be changed in a few seconds by the substitution of one slide for another. Thus, by keeping a few spare slides, the trader is able to alter the appearance of his display as often as he likes.

The contrivance can be placed in position without the aid of any tools, and the metal part of the frame in no way interferes with the lighting effect. When the ordinary white light is required, it is not necessary to remove the frame; only the slide need be taken out. Ample ventilation is provided and fire risks are entirely obviated.

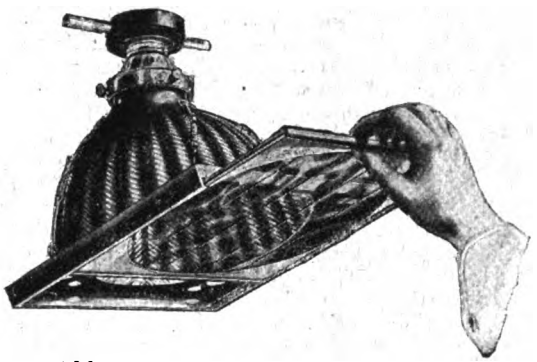


FIG. 2.—ILLUSTRATING THE SIMPLICITY WITH WHICH THE SLIDE CAN BE PLACED IN THE COLOUR FRAME WITHOUT DETACHING THE LATTER FROM THE X-RAY REFLECTOR.

At least one of the largest London stores has already installed the B.T.-H. X-Colour-Ray attachment with complete success, and it is confidently expected that in the near future the device will be in general use in the windows of important stores throughout the country, who, in addition to correct lighting, are alive to the importance of novelty.

Further information will, we understand, be gladly supplied by the Illuminating Engineering Dept. of the British Thomson-Houston Co., Ltd., Mazda House, 77, Upper Thames Street, E.C.4.

A BRIEF SURVEY OF THE ELECTRIC TRAM.

Events move quickly in the electrical world, and this is well illustrated in considering the electrical tramway systems. It is within the memory of many of us when horse-traction was used in our large towns and cities, and in the case of "hilly" streets, as in Dundee, where steam traction was in use.

The electric tram compares unfavourably with the quicker and more elastic motor-bus system in carrying passengers from point to point, especially in busy hours. The latter can be distributed in congested districts, and not confined to a beaten track, and their increased speed means increased revenue.

In this brief historical sketch of our British tramways, it is no strain on the memory to go back to the 'eighties of the last century. Brighton claims the honour of having the first electric tramway, and it was laid down in 1883. Current was supplied at a pressure of 160 volts, less than one-third of that which obtains to-day. Originally, current was taken from two insulated rails, and after some years a third rail acted as the positive side of the system, the two running rails forming the return.

Shortly after the Brighton track was constructed, Messrs. Siemens laid one down at Portrush, and the third rail was also used as the conductor to the motors. In the following year a street tramway was built at Blackpool. This was three miles long, and the pressure was raised to 230 volts. A departure was made by introducing the conduit system for current collection. This pioneer of the conduit was not very successful, and after some time on over-head trolley replaced the conduit, as it was found that sand and water got into the duct.

From that time until 1896 progress in electric tramway construction was slow, but in that year the Light Railways Act was passed, and an impetus thus given. It is allowed to-day that there are about 3,500 miles of tramway track laid in Great Britain.

A well-thought-out tramway system would have its power station centrally situated, the lines radiating from it. Direct current is mostly used for propulsion, though alternating current at high pressure may be produced at the generating station. The average pressure at the motors is from 500 to 550 volts, and allowing for a voltage drop of 50 in the cables, feeders, etc., this would permit of a generating pressure of 600 volts at the higher value.

From the year 1 of tramway electric construction, that is, from 1883, to the present, no less than five methods of current collection have been used. These are:

(1) The "overhead" or trolley system.
(2) The "conduit" system.
(3) The "surface-contact" system.
(4) The "storage-battery" system.
(5) The "third rail" system.

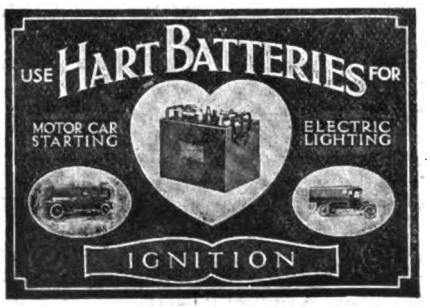
Of these, the first is by far the most common. The conduit system was adopted at first in some parts of London, but is open to the objection of being very costly. The surface-contact was tried at Torquay and Wolverhampton, but on account of the danger involved the Torquay track was abandoned. The storage-battery system has not been successful; when an installation is carried on a car, the weight is a matter of some consideration, while the diseases to which the cells are subject, as sulphating, buckling and disintegration, operate against them. This point is not of so much weight when cells are installed in a central station, as deterioration is less, and more time can be given to their care and maintenance. Their only measure of success lies in the fact that they may serve as an auxiliary to the generators during heavy loads, a battery of 60 cells giving a voltage of 132. In the third-rail system, suitable for private rights-of-way, the return is the running rails, while the third rail at the side supplies current by means of sliding shoes.

In direct-current transmission, the Board of Trade limit the load per feeder to 600 amperes at 500 volts, the drop in the rails to 7 volts, and the current density in them to 9 amperes per square inch.

In alternating-current transmission, the generating pressure is about 5,500 volts, and is lowered to 550 volts at the sub-station by rotary converters or motor generators.

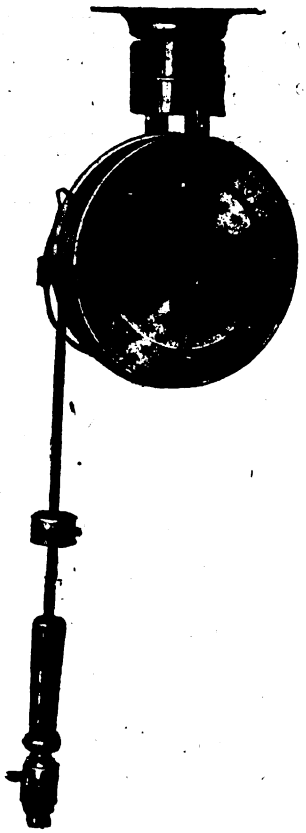
A HANDSOME SHOWCARD.

The illustration herewith gives a general idea of the very handsome embossed showcard, measuring 15 in. by 20 in., recently issued by the Hart Accumulator Co., Ltd. (Marshgate Lane, Stratford, E.) Finished in grey and white, attention is immediately focussed on the company's manufactures illustrated, which, like the showcard itself, are in the first rank of excellence.



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A NEW PATENTED SWIVELLING SELF-WINDING CABLE REEL FOR WORKSHOP USE.



A useful accessory for factory, workshop and garage use particularly, is the "Wayne" self-winding electric cable reel which has just been put on the market by the manufacturers, the Wayne Engineering and Equipment Co. (111-3, Great Portland Street, W.1). The device is shown in the accompanying illustration, where it will be seen that by its use (the head forms a swivel joint) light and power for small tools can be applied at any point in the works within a circle whose radius is the length of cable the drum will hold (25 ft.). The danger and inconvenience of loose wires is done away with, and also the possibility of broken and kinked wires.

We have examined the reel, and are assured that it is well made, the chief materal used being sheet steel, nickel-plated or enamelled. The current carrying parts are of ample section, and the contacts seem well designed. Further, the insulating bushes would appear to be of such a nature as to preclude failure. All parts are made by machine, and any replacement is thereby facilitated—the bulk of the parts are "pressed." Provision is made for earthing. It is impossible to describe the mechanism in the space at our disposal, but full particulars can be obtained from the manufacturers, who, we understand, are also prepared to send a reel complete on trial for three days on written application from any reputable house. Finally, we might record that, on learning the price, we were surprised at the lowness of the figure, considering the amount of detail involved in the production of the device.

THE EVOLUTION OF THE MOTOR VEHICLE FOR GOODS AND PASSENGER SERVICE.

At a recent Inst. of Transport meeting, Mr. P. F. Smith read a paper on the above subject. We are in agreement with most of his remarks, but cannot subscribe to the theory that the coming development of the petrol-electric vehicle will be at the expense of the battery car. The latter should find increasing application for transport work in towns especially, and particularly when run in conjunction with the Electricity Supply Authority. Nothing can take away the advantage of the possibility of the power being provided from the generating station most economically during "off-peak" hours.

Mr. Smith said he believed that the first commercial vehicle—a cab—was placed upon the streets of Canstatt by Daimler in 1896. The world had to thank Daimler for all we had to-day in internal combustion motor vehicle design. That might, said Mr. Smith, seem a very broad statement, but in most modern vehicles the brain and ingenuity of Daimler and his assistant, Maybach, might be discerned. Yet the British commercial vehicle manufacturer, although a slow starter, had beaten the world in design. Discussing types of motor vehicles, Mr. Smith expressed the opinion that when self-starters became universally an integral part of a petrol-driven machine, thus overcoming the serious objection the drivers had to-day to stopping and restarting their engines, the beginning of the end of the battery car was in sight. Concluding his paper—which contained a wealth of information as to the progress of diverse types of propulsion—Mr. Smith spoke optimistically of the petrol-electric vehicle. "One reads to-day much of safety first," he remarked. "I can state confidently that the petrol-electric system is the acme of this; for example, if a vehicle is being driven in exceptionally dangerous country, as in some parts of Wales, Cornwall, or Devon, a driver may at his discretion put his controller in the reverse position, and crawl down a hill at a rate of about two to three miles per hour, without having recourse to his mechanical brakes. Equally, if the engine should fail in the middle of a dangerous hill, the vehicle cannot run backwards at a greater speed than that mentioned above, because the electric motor automatically becomes a dynamo for the time being. Again, an extremely important fact is that we are yet in our infancy in the evolution and development of this type. We are waiting for engines which will 'turn' faster, or preferably, the internal combustion turbine, which will then permit of the production of much lighter electrical sets for a given output. The present hand control of the dynamo field resistance will become automatic, an electric brake control, if one cares to use it through the transmission shafts, can be easily provided, and if to-day the system cannot be considered absolutely fool-proof, it soon will be. My opinion is born of a strong conviction, the result of many years' experience of various forms of transmission. I believe that, in the absence of a force not yet known, or of a force not yet harnessed, in a few years from now the petrol-electric transmission will occupy the position which the 'gear drive' holds to-day, and that is the end to which I personally am working."

THE CHOICE OF MOTORS FOR INDUSTRIAL WORK.

Small motor applications are lucidly dealt with in a new publication (7855/2) issued by the Metropolitan-Vickers Electrical Co., Ltd. (Trafford Park, Manchester). The publication, which is in the form of a 36-page booklet, is thoroughly well illustrated as regards actual installations in most diversified industrial situations, and should prove of great value to many factory owners, as the characteristics of D.C. and A.C. motors are dealt with simply, but clearly and concisely. Illustrations of the different types are given, together with some notes on starting and speed control.

"English Electric Journal."—The July-Oct. issue contains a number of well illustrated technical articles, embracing the D.K. 34 light-weight ventilated tramway motor for small dia. car wheels, an investigation into the properties of a tramcar current breaker, the oscillating phase advancer, rolling mill drivers, a textile mill motor installation, and a note on the mechanical advantage of electric locomotives as compared with steam, by Sir Vincent Raven.

Faraday House Old Students' Association.—The Annual Dinner of the Faraday House Old Students' Assoc. was held at the Holborn Restaurant on Oct. 21, Mr. C. C. Paterson, O.B.E., the President of the Assoc. being in the chair. The Toast of Faraday House and its old students was proposed by Mr. L. B. Atkinson, and replied to by Dr. Alexander Russell. Mr. Partridge proposed the "Guests" in a very happy speech. He said that the industry had not yet fully recognised the debt it was under to Dr. S. Z. de Ferranti for his invaluable pioneering work in the early days. The toast was replied to by Dr. Ferranti and Sir John Snell. A large number of distinguished engineers were present.

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PAGES FROM OUR DESIGNER'S NOTEBOOK

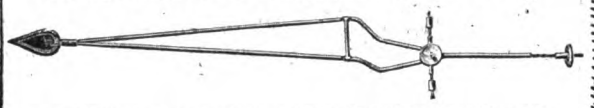
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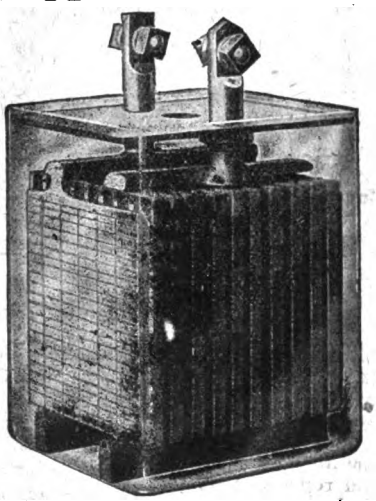
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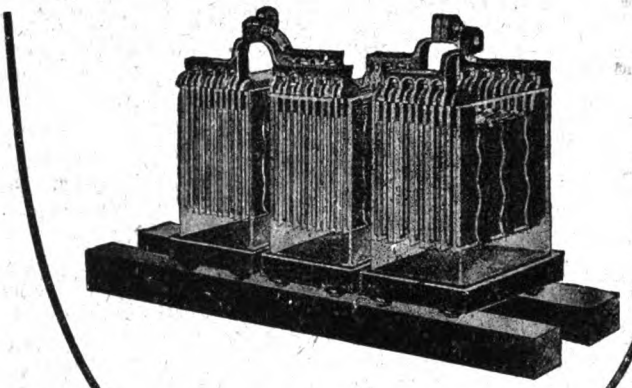
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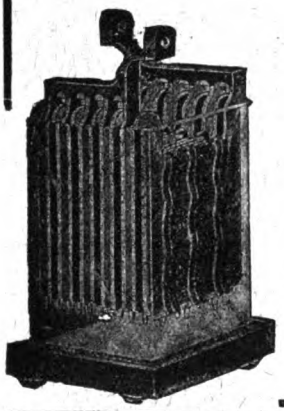
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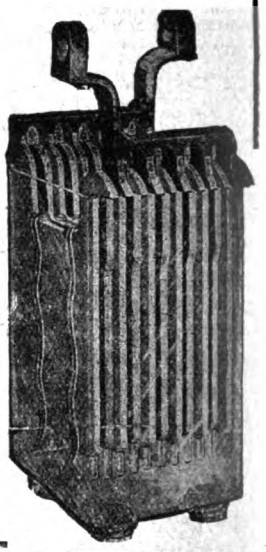
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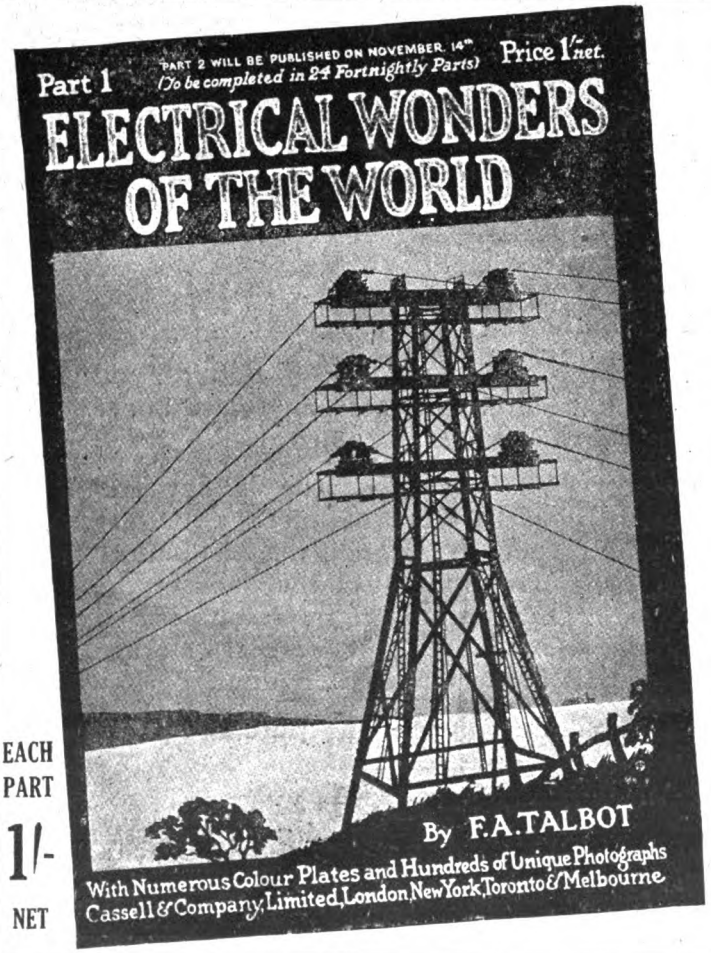


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Current Topics.

Electrical Measurement.

Has it ever occurred to you, dear reader, how very extensively electricity or electrical methods enter into the science of exact measurement? The foregoing query is prompted by an editorial in a Chicago contemporary, specially devoted to this subject of electrical means of measurement. The principal reason which has led to the adoption of electricity for quantitative measurement is the highly developed state of the art of electrical measurement in its own sphere as embracing the well-known electrical characteristics, electromotive force, amperage, resistance, etc. This first started with the physicist, and has been followed up by the engineer under compulsion, since the commodity in which he deals is intangible, and he was forced to develop satisfactory measuring apparatus. Later he became aware of the great importance of accuracy in electrical measurements, and carried the art to a high degree of perfection.

As a result for the most perfect method of quantitative measurement today, in practically every instance where even indirectly electrical means can be adopted, the electrical is far and away superior to other known systems. We have an excellent example in its application to the science of temperature measurement by the aid of the electrical pyrometer, which also lends itself to close and accurate temperature control within fine limits for certain industrial processes. Electrical tachometers, or speed recorders, are another instance of accurate determination, as is also the electrical micrometer, whose indications turn on the completion of an exceedingly fine contact in the indicating circuit.

Electrical methods of measurement also owe a good deal of their outstanding success to their extreme sensitiveness. Thus the electroscope is infinitely more sensitive than the spectroscope for the determination of the presence of certain elements, whilst the extreme sensitiveness of the microphone and of the telephone receiver are too well known to call for further comment. Electrical indicating apparatus also lends itself to enormous multiplication of effect. Take the case of a delicate Thomson reflecting galvanometer, in itself susceptible to currents which could not be measured by other means. With the aid of a small mirror attached to the moving suspension, and a reflected beam of light, the equivalent of an index pointer six or eight feet in length is secured, with the consequent multiplication of movement in the reflected spot of light on a graduated scale. Electricity also scores in the matter of convenience of application, since the actual indicator or recorder of measurements by electrical means can be located at any convenient spot, if necessary some distance from the scene of the actual measurement.

Autumn Leaves.

I recently commented on the failure of the electricity supply at Bingley, which is dependent upon neighbouring Keighley for its juice, and is served through the medium of duplicate overhead cables. Since the occurrence originally reported, there has been quite a local "breeze" over the matter, in which, it will be recalled, the Electricity Commissioners were called in to adjudicate. Their reply has since been received, and is to the effect that improved conditions might be anticipated if the insulators were renewed. To make matters worse, Keighley elected to have a breakdown of its own on a recent Saturday evening, thus throwing both districts into temporary gloom, and no doubt adding fresh fuel to the wrath of Bingley critics.

The cause of the failure was somewhat curious and unusual, being due to the accumulation of an abnormal quantity of fallen leaves, brought down by the swollen waters of the Worth and North Beck to the screens which filter the water at the power house intake, thereby leading to a shortage of water for the plant pumps. Mutual recriminations have been appearing in the local Press, and the Keighley Electricity chairman has given the Bingley Council a bit of his mind, pointing out that better facilities for testing the condition of the transmission lines exist at the Bingley terminals than at Keighley, if they only knew it and took advantage of the fact. He also states that, in regard to the defective insulators, the Commissioners' report is somewhat belated, inasmuch as new insulators were already on order, and instructions had been issued to substitute them for those of which complaint is made. It is to be hoped that the two corporations will soon settle their differences, and eradicate the defects which apparently exist in their respective electricity schemes, for these frequent breakdowns do not redound to the credit of electricity supply for public services.

Competition.

Competition is good for us all, and especially for the consumer or the public. It is the more refreshing, therefore, to read and study the presidential address to the Scottish Junior Gas Association of Mr. James Cubie, of Glasgow Corporation Gas Department. Commenting on the "therm," the new unit of charging for gas consumed on the basis of available heat energy per thousand cubic feet, Mr. Cubie referred to the desirability of establishing a common heat unit, on the principle of what is sauce for the goose is an equivalent complement to the gander. He recalled a pronouncement of Sir George Beilby to the effect that if gas undertakings are in the future to be paid only for the "therms" delivered to consumers, they, in turn, are entitled to throw at least a portion of the respon-

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sibility on the coalowners and miners by paying only for the latent therms contained in the coal purchased for gas-making.

Mr. Cubie goes one better by suggesting that the introduction of a thermic charge for coal introduces a new phase into the whole question of charges according to heating value; and, should coal come to be charged on a heating value basis, the time would be ripe when fixing the unit of charge for considering a common standard heat unit for gaseous and solid fuels and electrical energy. If on the introduction of a thermic charge for coal the electricity and gas industries were in favour of a common standard, the thousand and one references to the adoption of the one or the other would disappear, and permit of a straight comparison between gas and electricity.

Commenting on gas lighting, Mr. Cubie admonished his audience on the need for retaining the lighting load, and pointed out that only thirty years ago practically the whole output of gasworks was consumed for purposes of illumination. As a means for retaining the present consumers of gas for lighting, and to assist further development of the lighting business, Mr. Cubie advocates the supply of gas of regular quality and pressure, the inducement of consumers to discard cheap and unreliable burners, and, finally, systematic maintenance. He spoke strongly of the harm which had accrued to the gas industry and, conversely, the benefit which had been done to electric lighting, by the wholesale distribution of cheap and unreliable gas burners and fittings. I have frequently commented on this same subject in my past notes, and it would appear that at last our friends and competitors are waking up to the need for action in suppressing the trade in these wasteful and unsatisfactory appliances.

ELEKTRON.

THIRD ANNUAL DINNER OF THE E.P.E.A.

On Saturday, the 29th ult., the Southern Division of the Electrical Powers Engineers' Association held their third annual dinner, with the members of the National Executive Council as chief guests. Many other friends of the association were also present.

An excellent dinner was followed by a good musical programme, between the items of which the speeches of the evening were sandwiched. After "The King" had been duly given with musical honours, the toast of "The Association" was proposed by Mr. Page, one of the moving spirits of the N.E.C., and, in reviewing its history, he mentioned the many difficulties they had had, and still had, to contend with, and stated that he was pleased to see that the direction of the society was towards cool and level-headed bargaining, instead of the hot-headed actions which nearly always lost that vital influence, public opinion. He hoped that the association would be powerful enough to look after the interests of the industry, particularly with reference to young engineers and the unemployed. There was now a Chartered Institution of Electrical Engineers, and he thought that situations should be filled from members of that institution, and thus maintain a high standard. He also mentioned that he had been looking through the journal, and complimented Mr. Waite, who, he understood, was the power behind the scenes.

Touching on the subject of the recent agreement with the E.T.U., he mentioned that sometimes it is essential to make compacts which are, on the face, undesirable, and yet which are really for the benefit of all concerned. He had read that the *Electrical Review* was keeping a fatherly eye on the association, and that therefore there was no doubt of their success and future prosperity. The trade, as with all others, was overcrowded, but not with competent men; and, if the association continued on its present path and maintained its high standard, it should go a long way towards smoothing the path of progress.

Mr. Jeffrey then rose to toast "The Ladies," who, he said, were the backbone of the association, as without their support they could never have done the necessary work to obtain the fine position it now held. He particularly praised Mrs. Parker, who had lost her husband every week-end for months while he had been travelling to different committees.

The toast of "The Visitors" was proposed by Mr. W. J. Oswald, who stated that the association considered it a great honour for the members of the N.E.C. to be their guests, and that this was a splendid opportunity of declaring that their aims were for the benefit of the industry as a whole, and not just to air petty grievances. They could work better as an association with the N.E.C. than if they were at sixes and sevens. It was a professional association, and they wanted only professional men in it. He also stated that he was very sorry to see the industry used by different political factions to their own ends, and that, with the help of the N.E.C., they hoped to overcome such interference, which did no good to the industry and only hampered progress. He also welcomed the manufacturers, who had done a lot to help them. Lectures by specialists on their different subjects were being given, and he hoped all would support them. Welcome was also extended to the Technical Press, who had helped them a lot. Criticism based on knowledge was welcomed, but criticism based on rumours did more harm than apologies could ever atone for. There was no mystery about the agreement with the E.T.U., and he hoped that all troubles would be cleared up. The association owed a lot to everybody, and thanked them one and all for their help, and trusted that bonds of friendship would be welded even stronger in the future.

A presentation was then made by the President (Mr. Heslope) to Mr. and Mrs. Parker. It took the form of a gramophone, a grandmother clock, and a gold wristlet watch for Mrs. Parker. After telling us of the splendid work Mr. Parker had done for the association, and the gratitude they owed both him and Mrs. Parker, the toast "Mr. and Mrs. Parker" was given with full musical honours. Mr. Thompson, Mr. W. J. Oswald and Mr. Lunn also testified to the wonderful way Mr. Parker had helped them.

Mr. Parker acknowledged the presentation, saying that he was very moved by their kindness, and that whatever he had done was with the invaluable assistance of the N.E.C. and committee of the E.P.E.A. Mrs. Parker also thanked them for their kindness.

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Replying to Mr. Page, Mr. Heslope thanked him for his kind treatment, and stated that the aims of the association were on the basis of a square deal emphasising the duties of the employer.

Mr. Wild and Mr. Lunn replied suitably for the visitors, and to the tune of "Auld Lang Syne" a most convivial evening was brought to a conclusion.

"SPARKER."

THE ELECTRICAL TRADES' BENEVOLENT INSTITUTION DINNER.

On Wednesday, the 26th ult., Sir Tom. Callender, J.P., presided at the annual festival dinner of this well-known benevolent institution, and after the usual loyal toast, he referred to the fact that the primary object of the institution was to grant pensions to those of the industry who fell upon bad times. So far, they had not had to grant any such pensions, but they would most certainly come along in the future, and in order to prepare for such eventualities all connected with the industry must endeavour to get the money *now*. He stated that he had not coupled any name with the toast, but added that Sir William Noble and Mr. Ll. B. Atkinson would speak in support. Sir William Noble then rose and remarked that although he was not in the trade, yet on the other hand he was the head of the engineering department of the trade's best customer. He referred to the fact that in the Civil Service the staff have practically to serve forty years before they can obtain a pension. On the other hand, there were many necessitous cases which cropped up long before that time arrived, and when he was in charge of the London division in 1907 many such applications for assistance came under his notice. In order to meet such cases special arrangements were made by the staff similar in character to the institution which we were now supporting, so that really the staff had its own private benevolent fund, which had proved of very great use. He also referred to the Postal Relief Fund, which was started in 1914, and stated with pride that the officials had raised for this fund nearly £450,000 in four years, and they had about 3,000 widows and 5,000 orphans who were receiving regular assistance. He wound up his speech with a quotation from Burns, which will be certain to appeal to every reader, namely: "Man's inhumanity to man makes countless thousands mourn." He thought that would touch the hearts of all who had any money to spare for such a worthy object as that Institution.

He was followed by Mr. Ll. Atkinson, the retiring President of the Institution of Electrical Engineers, who alluded to the position of affairs in our industry at the present time, and compared them with those existing a year ago. He stated frankly that these were unexpected changes, but if that was what could happen in the trade as a whole, then undoubtedly it could happen to the individual, as, indeed, we all knew to be the case. He referred also to the fact that many big firms have their own charitable and pension funds and that was the reason why so few claims had been made on the funds of the E.T.B.I. He was in due course followed by Mr. Lee Matthews, who proposed the toast of the ladies and coupled with it the name of Lady Callender, to which Lady Callender gave a brief but excellent reply, at the same time humorously remarking that in her opinion the ladies had been invited to the dinner in order that they might use their influence on behalf of the charitable objects of the association.

Mr. J. Y. Fletcher remarked that this dinner was a unique occasion, as hitherto we have had unemployment in our industry almost at the zero point and it was now almost at its maximum. He then proposed the toast of the chairman, to which Sir Tom Callender gave a suitable reply, and then went on to refer to Mr. Hawes and the work which he had strenuously undertaken as secretary of the Institution, and he likewise mentioned that contributions representing £410 had been received and promised during the evening, and this amount, together with the amount already received during the year, would make up a total of nearly £1,300. Mr. Hawes responded in a few brief words expressing the keen interest which he had always felt in working on behalf of the Institution and how much he appreciated the courtesies which he had received from those with whom he had been associated. He was glad to think that the industry was still lending a helping hand in support of the Association and hoped that it would continue to grow year by year.

An excellent musical programme, including songs by Miss Violet Openshaw and Mr. Edward Dykes, together with humorous songs at the piano from Mr. C. T. Sterndale Bennett, added much to the enjoyment of the evening.

ELECTRIC VEHICLES.

AT THE COMMERCIAL MOTOR EXHIBITION.

The electric vehicles shown at the recent Commercial Motor Exhibition at Olympia made a good display and naturally attracted very considerable attention, as the benefits to owners and drivers of both the battery and petrol-electric vehicles are more understood. At the same time many manufacturers can point to the large numbers of electric vehicles now giving excellent service on the road as convincing proof that their pioneer efforts were worthy of the money, time and brains bestowed on them. Further, new firms are taking up the manufacture of electric vehicles.

Agricultural and General Engineers, Ltd., showed a 2½-ton "Garrett" patent electric vehicle manufactured by Richard Garrett and Sons, Ltd., of Leiston. The standard sizes are 1½, 2½ and 3½ tons. The motor for the 2½-ton size is of 9 h.p., series wound and capable of 300 per cent. overload. About 30 miles can be travelled without recharging the batteries ("Ironclad Exide" are the company's standard), and a speed of 10 m.p.h. attained on good level roads. The controller, which is of the segmental drum type, is fitted with four forward and two reverse speeds, the controller lever being conveniently situated on the steering column. It embodies certain unique features and works in conjunction with the "Garrett" patent trip gear which is so designed that as soon as either foot or hand brake is applied the controller automatically returns to the neutral position. This arrangement renders it impossible for negligence on the part of the driver to result in an excessive rush of current through the motor or battery, with consequent damage to either or both, and prevents the risk of accidents arising from a sudden forward movement of the vehicle caused by the controller not being returned to the neutral position before the brakes are released. A pedal operated by the left foot is fitted in conjunction with a device for starting on hills. The chassis can be fitted with a variety of body work to suit varying conditions of load,

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the tipping gear, when supplied, being actuated by a separate motor conveniently placed under the driver's seat.

The electric vehicles shown by Ransomes, Sims and Jefferies, Ltd. (Orwell Works, Ipswich), included a 2-ton chain-driven tipping lorry with refuse collecting body, a 4-ton flat top lorry, two platform trucks, "B" and "C" types, and a runabout crane. The "Orwell" vehicles are made in a wide variety of sizes and designs, and so fill most industrial requirements. Space prevents our dealing at all fully with the company's various manufactures, but we shall be dealing later with the platform trucks and runabout cranes.

Newton Bros. (Derby), Ltd., exhibited a "Newton Derby Electric" chassis fitted with cab and steel body suited to about 2½ tons of average refuse. In this case two slow-speed traction type motors are fitted, each driving separately one rear road wheel by means of one straight tooth pinion gearing into one internally toothed steel ring attached one to each of the two rear road wheels. The motors are double spring suspended.

Among the other electric vehicles shown were the new 5-ton tipping wagon built by Clayton Wagons, Ltd., of Lincoln, and the 2½ton chassis by Guy Motors, Ltd. (Wolverhampton). The General Vehicle Co., Ltd. (43, Shoe Lane, E.C.4), exhibited a 2-ton G.V. vehicle for refuse collection, a 3½-ton vehicle for brewery work, and a 5-ton vehicle with three-way tipping body for the carriage of coal, road metal, etc.

An imposing display was that of Tilling-Stevens, Ltd. (Maidstone), who showed a petrol-electric char-a-banc, a 4-ton (type T.S.4) petrol-electric chassis, a double-decked omnibus, and a 2-ton (type T.S.5) chassis. This is similar to type T.S.4, but smaller. The general principles of construction and smooth running qualities of these vehicles are well known. We refer to these vehicles elsewhere.

Among the varied collection of electrical accessories we noted that the Conner Magneto and Ignition, Ltd. (Stoke, Coventry), showed several types of C.M.I. magnetos, together with various electrically-driven models to demonstrate sparking characteristics at low and high speeds. Secondary battery (coil) ignition was represented by a display of apparatus with working models showing the characterisation of uniform spark at all speeds. The C.M.I. magneto impulse starter was also shown. This is a simple, efficient and durable device for giving the armature a short initial movement in the magnetic field, thus producing a spark equivalent to that obtained in normal running at 500 r.p.m.

One of the most interesting exhibits in this stand was a working model of the "Lorrilite" generator. This generator is a small, self-regulating magneto-dynamo designed expressly for lighting headlights and, if necessary, the tail lights of motor-lorries and similar vehicles. The drive is by belt from the engine shaft, a simple friction clutch, operated by a Bowden wire control, being embodied in the dynamo pulley, so that the armature can be disengaged when the lights are not required. The armature shaft and the clutch pulley are mounted on high-grade annular ball bearings and no lubrication is required beyond re-greasing at long intervals. Another feature was a complete range of Osram lamps for automobile lighting, including all standard voltages and candle powers for headlights (both vacuum and gasfilled), side, tail, dash and steering pillar lights for British, American and French cars. Tubular and festoon lamps for car interior lighting were also included. Various sizes of Osram vacuum and gasfilled lamps were shown for garage and workshop lighting, and a note of novelty was struck by the Osglim letter lamps for use in illuminated garage signs. "Geeko" ignition accumulators, of capacities varying from 20 to 100 ignition ampere-hours, and made up in 2, 4 and 6 volt. units, "Geeko" starter and lighting accumulators of capacities from 100 to 20 actual ampere-hours, in 2 volt units, and a representative selection of Pirelli-General wires and flexibles for car and garage use completed this exhibit.

FINSBURY TECHNICAL COLLEGE.

That the Old Students' Association has really got going again is shown by the appearance of an issue of the Magazine dated October, 1921, Vol. IV., No. 2. Considering the difficulties which the hard-working enthusiasts had to contend with, the progress has been most satisfactory, and it is to be hoped that there will now be a steady accession of old students so as to ensure the association attaining a strong financial position. The editor of the Magazine appeals for particulars of old students' doings so that the section devoted to this may become of real interest once more. A good start has already been made. Particulars of the Manchester Local Section are given, and a suggestion made that one could also be effected to embrace Birmingham, Rugby, Coventry, etc. Among other news items is to be found particulars of past and forthcoming "functions." Copies of the Magazine, issued *free* to members, can be obtained from the Editor, Mr. W. B. Thompson, "Ellerary," Regent Road, Altrincham, near Manchester, for the sum of 2s. 6d. By the way, the annual subscription is now: London and Manchester members, 10s.; other members, 5s.

Information Wanted.—Will anyone who knows the whereabouts of W. J. Stephen (at Finsbury Technical College 1912-14) advise R. A. Sutcliffe, Kineton, Warwickshire? He was last heard of in the Tank Corps.

Answers to Correspondents.

ANXIOUS STUDENT.—Yes, we saw the cutting from the *Daily Mail* which you have sent us and can quite believe it. English printing costs must come down heavily before publishers over here will show any special enterprise. Meantime urgent printing orders can be executed cheaply in Holland or Germany. The Trade Union leaders who control affairs over here are apparently of opinion that it is better to let their members be out of work and drawing the dole than to ask them boldly to face the fight, make a big cut in wages—preferably by giving a greater output for the same money—draw in their belts a bit tighter and ultimately win out, as we feel certain English labour, whether muscle or brain, can do in the long run. The latter course would certainly help to restore enterprise.

Strasburg Hygienic Exhibition.—To celebrate the centenary of the birth of the great French chemist, Louis Pasteur, an Interallied Hygienic Exhibition will be held at Strasburg from May to October, 1923. A special feature will be its second division "Hygienic Towns," which will include heating, lighting, ventilating, municipal services, etc. Full information will be supplied on application to Exposition Interalliée d'Hygiéne, Strasbourg 1923. 2e Section: Hygiéne Urbaine, 1, Quai Lezai-Marnèsia, Strasbourg.

Wanted, Another Million.—The League of Nations Union (15, Grosvenor Crescent, S.W.1), wants one million pounds to continue its campaign of demonstrating to the general public that the League of Nations is the only alternative to war. In support the following resolution may be quoted: "This meeting of business men held at the Mansion House in the City of London, on Tuesday, October 18, is of opinion that the only way of saving the deplorable situation in which British business finds itself is by increasing internationally co-operation; that the League of Nations is by far the most hopeful means of securing this result; that we should therefore support the League; and that the most effective way of doing so is to help the League of Nations Union to obtain the funds necessary to get the British people solidly behind the League. This meeting accordingly commends the Union's appeal to the support of commerce and industry throughout the country."

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TELEGRAPHY.—GRADE I. (1921).

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in April, 1921.

(*Continued from page* 585.)

Question 9.–Describe, with sketches, the construction and adjustments of a non-polarised sounder. What is the probable cause of the receipt of sticky signals on a sounder?

A.—Fig. 1 shows the side elevation of an ordinary sounder. *A A* are two coils abreast joined in series and wound on soft iron cores to a total resistance of 21 ohms. The coils are shunted by a resistance of 420 ohms, giving a joint resistance of 20 ohms. The

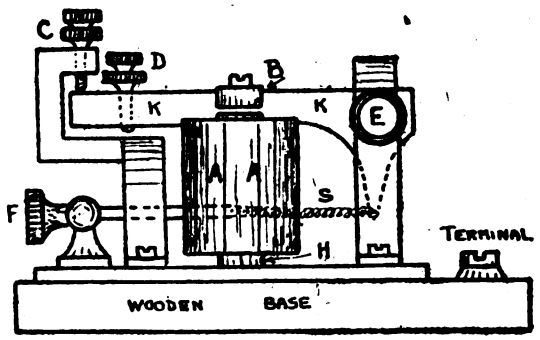


FIG. 1.

object of the shunt is to prevent sparking at the contacts of the local relay at break, due to the self-induction of the sounder coils. The two ends of the coils are connected to terminals as shown in Fig. 2, which is a dia-

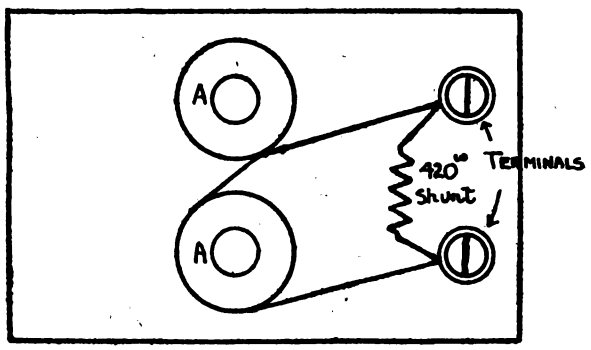


FIG. 2.

gram of the internal connections. The cores are of split soft iron tubing, and rest on a soft iron yoke *H* thus forming an electromagnet. *K K* is a brass lever pivoted between two screws *E*, and is held normally against the top stop *C* by a spring *S*, the tension of which is regulated by the milled head *F*. *B* is a soft iron armature fixed at right angles to the lever *K K* above the cores. When a current of requisite strength flows in the coils the cores become magnetised, attract the armature and pull down the lever against the tension of the spring *S*.

The adjustments of the sounder are four.

(1) The pivot screws *E* should be adjusted so that the lever *K K* works freely up and down without side shake.

(2) The screw *D* should be adjusted until the armature *B* when pressed down is just clear of the cores.

(3) The limiting screw *C* should be adjusted to regulate the amount of play of the armature.

(4) The screw *F* should be adjusted to regulate the tension of the spring *S*, until the armature responds without signals missing or running together. The tension should be such that the lever *K K* returns to the upper stop *C* with the same force as that with which it is drawn down by the current.

The above is a description of the non-polarised sounder used with primary cells; for secondary cell working the sounders are wound to a resistance of 1,000*w* with a 9,000*w* shunt, giving a joint resistance of 900*w*. The adjustments are the same as those outlined above.

Sticky signals would probably be caused by the presence of a considerable amount of residual magnetism in the cores, and as this is not appreciable in well-annealed iron, the inference would be that the iron cores were insufficiently softened. This defect may be remedied by withdrawing the cores, making them red hot and allowing to cool gradually.

(*To be continued*).

THE TELEGRAPHISTS' GUIDE. By BELL and WILSON. New (8th) edition, revised and brought up to date by a C.T.O. expert of high standing. 20th thousand. Profusely illustrated. 5s. 6d. net, post free from ELECTRICITY Office. The standard for Grade I.

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RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 128.

Is it possible to measure the insulation resistance of a three-wire system without interrupting the service? If so, will you please explain to me how this would be done.—"TESTER."

QUESTION No. 129.

I wish to make an electric kettle for use on a single-phase, 230 volt supply. I would appreciate any details that will enable me to do this.—"JOINTER."

(*Replies to Questions Nos.* 128 *and* 129 *must be received not later than November* 26, 1921.)

Burnley.—The Electricity Committee on Oct. 20 approved an ambitious scheme for the centralisation of the distribution of electricity. The project covers the mid-Lancashire district and has been prepared by representatives of electrical undertakings in this area. An advisory board will be set up and there will be co-ordination between neighbouring authorities so as to ensure the cheapest possible supply of electricity in order to conserve capital. The Nelson Town Council have also approved of the scheme.

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SUBMERSIBLE ELECTRIC MOTORS FOR MINE'S PUMPS.*

By A. J. Ramsay.

(*Continued from page* 600.)

For machines in permanent positions, and in cases where they are likely to be submerged for long periods in accessible positions, the bearing housings are fitted with automatic lubricators. This type of machine should be extremely useful in "headings" and "deeps," particularly as it can be worked in every conceivable position without alteration of any description.

Fig. 2 shows the characteristic curves of one of these 6 in. machines. At 750 galls. per min. the pump delivers at a pressure equal to 78 ft. The overall efficiency of the motor and pump at this point is equal to 56 per cent., the power factor of the motor is equal to 87 per cent., and the input of the motor is 32 h.p. It will be noted that the maximum power input with the pump delivering

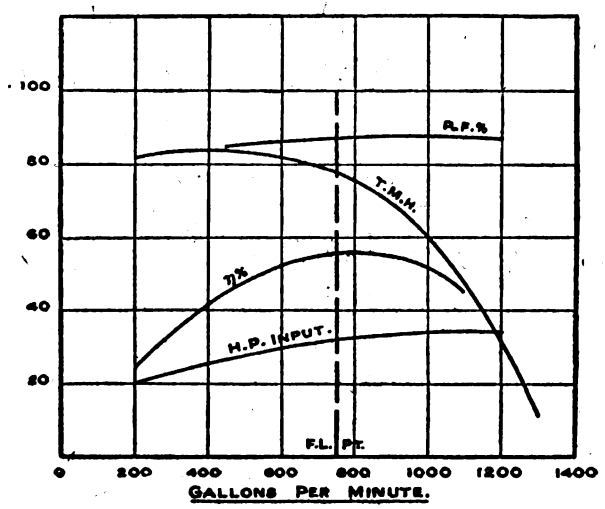


FIG. 2.—PERFORMANCE OF 6-INCH MOTOR PUMP.

at reduced heads down to zero is only 35 h.p., which represents a maximum increase of only 9.4 per cent. on the normal full load h.p. These tests were taken with the pump submerged; with the same machine running on suction, the set is practically self-regulating, which shows the good results that can be obtained in this respect by correct design of the impeller blades and suitable proportions for the pump casing. As a comparison, Fig. 3 gives similar curves for a 4 in. pump delivering half the quantity of water at the same pressure. The pump is of older design, and it will be noted that although the characteristics are quite good the h.p. input curve rises more steeply.

PORTABLE SETS IN WORKINGS.

In dip or deep workings this type of motor pump should prove indispensable as an auxiliary to the main sets and particularly where used for de-watering old workings. The gradient of the working is immaterial, and by mounting units on a suitable skid or trolley and coupling sufficient sets together in series any conceivable problem could be tackled.

The question of coupling up the feeding cable supplying the motors is of great importance. The cable would generally contain four cores, one of which would be connected to earth. In order to keep the cable winding drums down to a suitable size, and to facilitate handling, the lengths should not exceed 100 ft. for medium-power machines. Cable couplings for this work should comply with the following conditions:—(1) Robust construction, combined with minimum weight; (2) absolutely watertight; (3) fixed phase relation—that is, it must be impossible for the two halves to go together in the wrong position; (4) comply with the Home Office regulations; (5) high insulation resistance; (6) ample contact areas

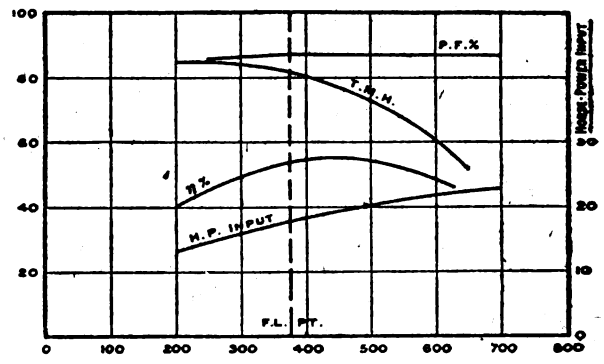


FIG. 3.—PERFORMANCE OF 4-INCH MOTOR PUMP.

These points are satisfactorily embodied in the "submersible" cable coupling. Fig. 4 shows an assembled view of a complete coupling. The case is made of naval brass, and the block in which the contacts are mounted is of non-hygroscopic fireproof material of high insulating properties. The electrical contacts are of hard-drawn copper of the "knife" pattern, riveted to gun-metal blocks

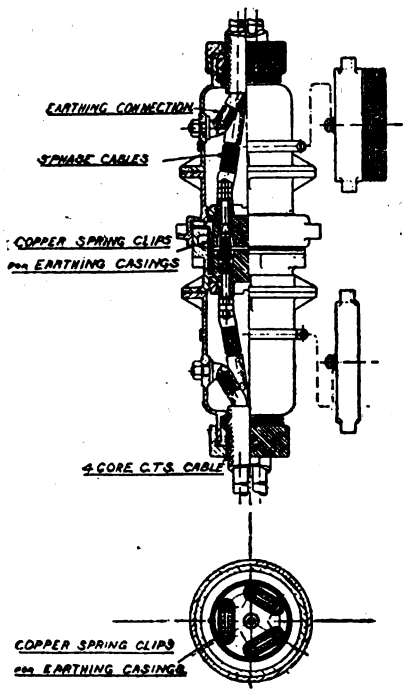


FIG. 4.—FOUR-POLE CABLE COUPLING.

sunk into recesses in the insulating block, and arranged so as to give a long leakage path. Two copper studs are screwed into each contact base, and these pass through holes in the insulating block and are fixed with an independent locking-nut. Connected to these studs are the three sweating sockets. The fourth or earth connection is

*Abstract of paper read before the North Staffordshire Inst. of Mining Engineers and first published in *The Mining Electrical Engineer*.

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bolted to the coupling case. The distance between the end of each half-coupling and the top of the contacts is such that the male and female contacts are completely separated when breaking a joint before the casings become parted. Similarly in making a joint the "earth" is made first.

(To be continued.)

Correspondence.

A DANGEROUS GERMAN INVENTION.

To the Editor of ELECTRICITY.

SIR,—My attention has been drawn to a device issuing from Germany for lighting gas by means of the Public Electric Supply in a house or building.

I am sorry I have not been able to get enough circulars to go round, but the following description will probably satisfy you that the Industry and public should be warned against the use of this dangerous invention.

It consists of a *single* flexible cord attached to a stick-like handle, at the end of which, so far as can be gleaned, there is a sparking point, probably with some resistance in series. The flexible cord is either plugged into a plug hole on the wall or attached to a switch, and the device is used by turning on the gas and flicking the burner with the sparking point.

Of course, the earth connection is provided by the gas stove, and where that is connected with a rubber pipe, the circular recommends the running of a bare wire to connect the body of the stove with the metal gas piping.

No doubt, when used, this device does light the gas, but may do all sorts of other things also.

It appears to be against the rules of every supply undertaking, to be dangerous to the owners of the gas system, and to offer risk to the user both of shock and of fire, and would presumably produce difficulties with the Fire Insurance people.

You may care to make some reference to this in your journal.—Yours faithfully,

J. W. BEAUCHAMP,
Director and Secretary.

The E.D.A.,
Hampden House,
84, Kingsway, London, W.C.2.
October 25, 1921.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]*

THE HARDWARE TRADE'S DIRECTORY, 1920-21. (Armstrong Horton and Co., Ltd., 6s. 9d.)—Congratulations to the publishers on the issue for the second year of this very useful work of reference. Apparently it is the only *annual* Directory that is published in the interests of Ironmongery, Hardware, Machinery, Engineering and Allied Trades, and its 400 odd pages contain an enormous number of addresses of firms associated with those wide-spread industries as well as in the useful classified index of branded goods, trade marks, proprietary articles, etc. The book is one which will be appreciated by all who are connected with the hardware trade.

POCKET REFERENCE BOOK FOR PROJECTIONISTS AND MANAGERS. By J. R. Cameron. (New York.) 150 pp. illustrated. (Rentell, 4s. net.)—This pocket book represents a collection of tables, rules and data reproduced from the author's larger works and from certain other works. The size of the book is convenient for the pocket and no doubt the volume will be very useful to American operators, particularly since it includes particulars of the rules in force in America, the central station supply available in various American cities, and a useful American trade directory. None of these features is of direct utility to operators in

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By H. F. Trewman, M.A.
ELECTRICITY IN STEEL WORKS.
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By W. M. Thornton, D.Sc.
INDUSTRIAL AND POWER ALCOHOL.
By R. C. Farmer, O.B.E., D.Sc., Ph.D., F.I.C.
WATER-POWER ENGINEERING.
By F. F. Fergusson, A.M.Inst.C.E.
BOILER INSPECTION AND MAINTENANCE.
By R. Clayton.

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HIGH-TENSION SWITCHGEAR.
By H. E. Poole, B.Sc. (Hons.). A.C.G.I., A.M.I.E.E.
HIGH-TENSION SWITCHBOARDS.
By the same Author.
POWER FACTOR CORRECTION.
By A. E. Clayton, B.Sc., A.K.C., A.M.I.E.E.
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COAL-CUTTING MACHINERY.
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GRINDING MACHINES AND THEIR USE.
By T. R. Shaw, M.I.Mech.E.
BELTS FOR POWER TRANSMISSION.
By W. G. Dunkley, B.Sc. (Hons.).
CONTINUOUS CURRENT ARMATURE WINDING.
By F. M. Denton, A.C.G.I., A.M.I.E.E.

"The book will be appreciated and enjoyed by all those who have found the principles of armature winding to be troublesome; and particularly by those who have been worried by wave winding."—THE ELECTRICIAN on *Continuous Current Armature Winding.*

TIDAL POWER.
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this country, hence we cannot conscientiously recommend this volume to our readers, particularly as a number of the tables have been reproduced by a photographic process on such a small scale that it is very difficult to make out the figures in some cases.

THE PRACTICE OF ELECTRICAL WIRING. By D. S. Munro. 268 pp., 96 figs. (*Electrical Review, Ltd.*, 5s. net).—Of the many books on "electrical wiring" this one is probably the most exhaustive, and at the same time, of the most use to the installation engineer, contractor and studious wireman. In this revised edition the author has brought right up to date his previous well-known book, and has not failed to give his personal opinion on some of the newer patented systems now on the market. He is a sturdy opponent of "the lowest tender," and believes that "apprentices should be trained first upon the best class of work, then they may be trusted with cheaper or less durable appliances. The worst material skilfully and conscientiously fitted, is better than an ideal system spoiled to secure an unjust profit or a very low price." While we agree, in general, there are many practical difficulties in the realisation of the foregoing sentiments.

Space prevents any detailed reference to the contents of this pre-eminently practical and well-illustrated detailed treatise on an important subject which far too often gets scant attention instead of the careful, studied consideration necessary for safety, reliability, neatness and economy—in its broadest sense. Anyone ignorant of the author would not have to read many lines before being convinced that he was master of the subject, and knew what he was writing about. Moreover, Mr. Munro is not ashamed of his opinions, and his frank statements cannot but tend to the elevation of the art of wiring.

Various Items.

Leeds.—It is estimated that the reduction in wages of Leeds tramways servants, which takes effect on Nov. 1, will result in a saving of £10,000 a year on the Corporation Electric Tramway Service.

University College.—We acknowledge receipt of the voluminous University College Calendar for the Session, 1921-2. As usual full details concerning the multitudinous activities of the College are set forth.

Inst. E. E. Informal Meetings.—At 7 p.m. on Monday next, the first of this season's Informal Meetings will be held in the home of the I.E.E., when the President, Mr. J. S. Highfield, will initiate a discussion on "How Best to Speed up Electrical Progress."

Ystradgynlais and Electric Light.—The U.D.C. have decided to purchase the undertaking of the Glantawe Electric Supply Co., at a cost of £18,000 plus £350 for a new booster. The clerk has been instructed to enter into negotiations with the company and also to make application for a provisional order from the electricity commissioners.

New Electrical Co.—Cesco, Limited, a private company has been registered with £6,000 capital in £1 shares for the purposes (1) the acquisition of the business of the Commercial Electric Supply Co., and (2) relating to their appointment as permanent joint managing directors in carrying on the business of electricity for light, heat, motive power or otherwise at Cardiff and elsewhere.

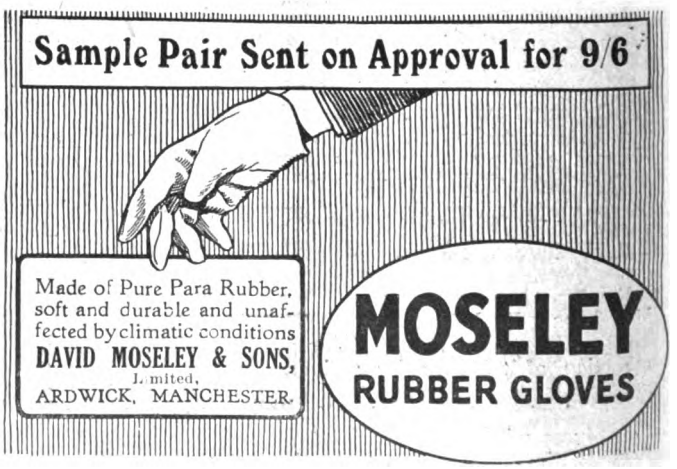
Newport's Submarine Electric Cable.—The Newport Corpn. have completed the laying of a submarine electric cable from their power station on the east side of the River Usk to the western side. This it is contended will prove a financial success, inasmuch as it will save the laying of cables along Corporation Road over the river bridge, down to the new ironworks of Messrs. Whitehead at Mendelgief. The submarine cable has been laid in a trench 8 feet below the bed of the river, direct from the power station on the one side to the Ebbw Vale Company's wharf on the other. This is part of a new scheme of extension of the Corporation Electricity undertaking at a capital outlay of £200,000, and one of the objects in view is to supply energy to the large works of Messrs. Whitehead. At the enquiry it was stated that the firm had entered into a long-term agreement under which they will pay the Corporation up to as much as £20,000 per annum with a minimum of £8,000 per year for energy.

Tenders Accepted.—Johnson & Phillips, Limited, have just been entrusted by the Post Office Engng. Dept. with the manufacture, supply and laying of a trunk telephone cable between Glasgow and Edinburgh. This contract comprises 46 miles of 204-pair cable.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 11th inst. at Caxton Hall at 8 p.m., Question and General Discussion evening. On Saturday, 12th inst. at 2.30, Visit to the Locomotive Sheds of the G.N. Rly. at King's Cross; and on Friday, 18th inst. at Caxton Hall at 7 p.m., Annual General Meeting.—On Monday, 7th inst. at 5.30 p.m., Mr. C. H. Naylor will read a paper on "Extraction Turbines" before the Society of Engineers in the Apartments of the Geological Society, Burlington House, Piccadilly.

"The Practical Metal-Worker."—We have received from Messrs. Cassell & Co., Ltd., Part 1 of this new publication which is entitled: "A Workshop Guide to the Practice of Mechanical Engineering." It is a work which will be completed in 24 parts, and is to be written by experts as well as lavishly illustrated. It will be a comprehensive and up-to-date guide to the working of metal, and part 1 now before us opens with an interesting résumé of the story of metal working, after which it goes on to describe such things as benches and simple tool equipments, hammers, chisels, saws, files, scrapers, and other tools which are used by the practical mechanic. It will we think appeal to a a very large number of the readers of this paper, and we commend it to their attention. The price is 1s. each fortnight, and it can be ordered through any newsagent.

Freemasonry.—On Friday the 28th ult. the annual Installation Meeting of the Kelvin Lodge No. 3,736 was held at Mark Mason's Hall, when Mr. H. Porter-Cox, the W.M., installed Mr. E. E. Sharp as his successor in the Chair. In this instance particular interest attached to the ceremony, inasmuch as Mr. Sharp is already reigning Master of the Electric Lodge, so that he is now actually reigning over the two Masonic Lodges which are most intimately associated with the electrical profession. The officers appointed were: Messrs. P. C. Ebner, S.W.; A. Forbes Dick, J.W.; Ernest J. Willcock, P.M., 2087, Treasurer; H. W. S. Rentell, L.R., Secretary; Edwin J. Reid, P.A.G. Supt. of Works, D.C.; W. E. Gundry, S.D.; Louis H. Euler, J.D.; T. E. Pickford, A.D.C.; J. Osborne Pearston, P.M., Almoner; A. W. B. Wilson, Organist; C. C. Wilson, Dep. Organist; Robert C. Graseby, I.G.; Charles G. Maisey, Archibald P. Welch, F. E. Phillips, F. H. Williams, Stewards; and Frederick Banchini, P.M., Tyler. Among those who were present at the banquet which followed the ceremony were Percy Still, P.G.D.; Charles F. Quicke, P.G. Supt. of Works; F. A. B. Lord, P.A.G.St.B.; John W. Elliott, P.Prov., J.G.D. (Herts); G. T. Fairbrother, P.M., 2455; W. B. Ross, P.M., 2767, C. H. Wordingham, Past President, Inst. E. E., as well as many other gentlemen intimately associated with the electrical industry. Mr. Still responded to the toast of the Grand Lodge Officers, and complimented the Kelvin on its rapid growth, and also on the way in which the members had worked for the Craft Charities, while Mr. Wordingham, who replied on behalf of the visitors, appealed feelingly for the cordial co-operation of all present these difficult times. Altogether a function well worthy of our great industry.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
NOVEMBER 11, 1921.

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NEW PLANT AT SUNDERLAND.

In common with every other manufacturing town in the country, Sunderland found it necessary to make arrangements for considerably adding to its generating and converting plant before the war was finished.

The additions decided upon included a 10,000 k.v.a. (1,500 r.p.m.), three-phase, 50-cycle alternator set for the main Corpn. Generating Works at Hylton Road, while in the neighbouring Dunning St. sub-station there were installed 2 1,500 k.w. motor-generator sets, two "Kapp" phase advancers for improving the power factor of the motors of these sets, and a 20-panel low tension switchboard, for general low tension D.C. supply. All the items of electrical plant just referred to were ordered from the General Electric Co., Ltd., and manufactured at the Company's Witton Works.

The reason which decided the Corpn. in selecting motor generators for such high outputs in comparison with rotary converters was the fact that the voltage of the D.C. side could be raised gradually from a low value of a few volts up to full voltage. This, of course, is not possible with

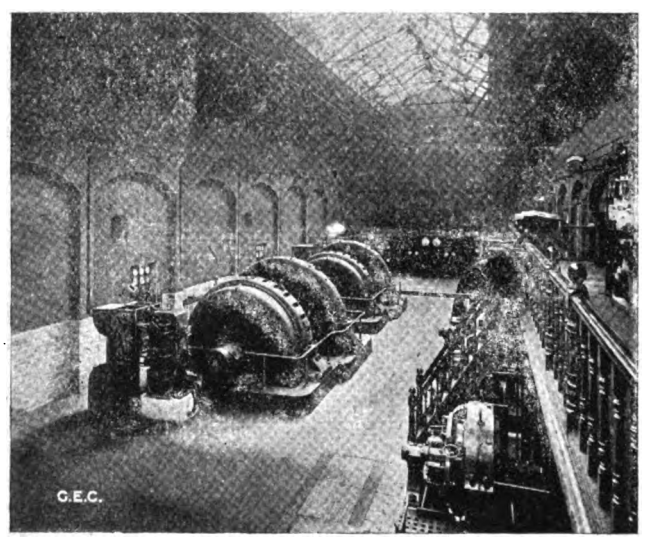


FIG. 1.—GENERAL VIEW OF THE DUNNING STREET SUB-STATION.

rotary converters but is of the greatest importance in cases where a total shut down of a large lighting system is to be taken into account, and where a gradual replacing of the supply without the burning out of consumers' apparatus is a necessity. The two motor-generator sets seen in Fig. 1 are generally in accordance with standard practice. The motors are rated at 2,120 h.p., 5,300 volts, 50 cycles, 300 r.p.m., the generators being 1,500 kw., 220 volts. In view of the heavy currents to be dealt with, the commutators are divided into two halves, so as to avoid undue heating in the individual sections.

The phase advancers, one of which is seen in Fig. 2, are, however, probably the most interesting items of plant in the sub-station. These are of the "Kapp" type, being based on the principle that when a conductor carrying A.C.

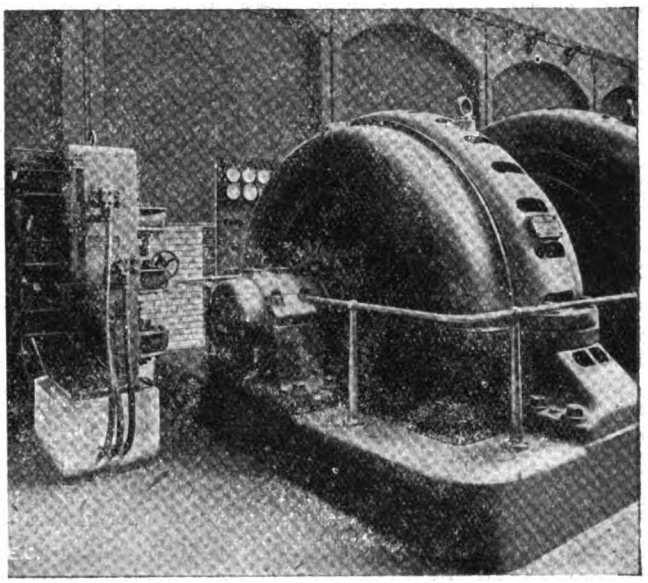


FIG. 2.—ONE OF THE TWO 2,120 H.P. MOTORS DRIVING 1,500 KW. GENERATORS, SHOWING 6-ARMATURE "KAPP" PHASE ADVANCER.

moves in a magnetic field, a current is induced in the conductor which leads the e.m.f. by 90 degrees. The main component parts of the phase advancer are very similar to those of a D.C. machine. Usually for each phase of the A.C. supply a two-pole magnet system with armature and commutator is provided, but in view of the size of the motors in the present case, two such units per phase were decided upon. The main frame of the phase advancer is a rectangular casting to which are bolted the poles, the armatures and commutators being supported by bearing brackets which are also bolted to the frame. It will at once be realised that this construction affords a mechanically simple machine. The field poles are excited from a local D.C. supply. The armatures are connected in series with the rotor of the induction motor and the main supply. By this arrangement the A.C. in the armature conductors leads the e.m.f. The armature does not rotate, but oscillates with a frequency depending upon the slip of the induction motor.

Points to be noted in the "Kapp" phase advancer include:—

(1) There are no high-speed moving parts. In addition a very rigid construction of moving parts is possible due to the small number of armature conductors and commutator bars.

(2) No mechanical connection with the motor.

(3) Can be placed in any convenient, out-of-the-way situation, and requires little floor space.

(4) The induction motor with phase advancer preserves its synchronous characteristics, and the possibility of

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hunting or falling out of step with fluctuations of the supply, which is a drawback of the synchronous motor, is avoided.

(5) The power consumption of the advancer is about ½ per cent. of the full load power of the motor. This small amount of power is far more than compensated for by the increased efficiency of the motor.

(6) The advancer acts entirely automatically, no adjustments being required during running. Generally speaking, the excitation of the phase advancer can be adjusted once and for all.

The 220-volt switchboard controls the two 1,500 kw. generators, fourteen 1,000 amp. feeders, one leakage and earth panel, while two panels are left blank. The heavy bus bars necessary are erected in a very neat and efficient way. The bars are clamped to plates which are carried on extended stems, heavy flat bends being thus done away with. In consequence, cleaning operations are much facilitated, and the smaller connections can be run to much greater advantage than would otherwise be possible.

It is interesting to note also that the Sunderland Corpn., has two 900 k.v.a. G.E.C. alternators and several 250 kw. G.E.C. motor-generators, supplied some years ago, still in operation, while a 1,000 kw. G.E.C. rotary converter is on order.

In conclusion our thanks are due to Mr. A. S. Blackman, M.I.E.E., the Borough Electrical Engineer, for allowing these particulars to be published.

WEST RIDING (AIRE AND CALDER) ELECTRICITY DISTRICT.

The Electricity Commissioners have decided that the area provisionally determined be confirmed, subject to the inclusion of a few small districts. The existing generating stations at Bradford, Halifax, Huddersfield, Keighley, Leeds, Thornhill and Wakefield are to be inter-connected, the existing generating plant, together with the extensions already authorised, and the addition of another generating set to be accommodated in the Whitehall Station of the Corpn. of Leeds, being estimated to meet the requirements of the district for several years. Having regard to the advantages of the Ferrybridge site and to the anticipated developments in the eastern and southern parts of the district, a new station is to be constructed forthwith on this site by the Power Coy., and linked up with the inter-connected system referred to. As the negotiations between the conference of local authorities and the Power Coy. for the sale and purchase of the company's undertaking failed, a Joint Electricity Authority is to be formed. With a view to ensuring the most efficient use of existing generating plant, and to avoiding unnecessary expenditure on transmission lines in certain parts of the district, the district is to be divided into two agreed areas, A and B, A being that which can be best supplied from the inter-connected existing municipal stations, and B being the remainder of the district which should be supplied by the Power Coy.

To give effect to their proposals the Commissioners have decided to prepare a Draft Order establishing a Joint Electricity Authority for the whole district as amended, and providing:—(*a*) For proper representation on the Joint Authority. (*b*) For the administrative expenses of the Joint Authority not properly chargeable as part of the cost of electricity supplied, or to capital, or not met out of contributions from local authorities or other bodies represented on the Joint Authority, to be met by all the authorised undertakers in the district; and for any excess of expenses of the Joint Authority over the receipts which may arise from the supply of electricity from the inter-connected system to be met by the authorised distributors connected with the system. (*c*) For the control by the Joint Authority of the working of the centralised system of inter-connected generating stations, such control to be exercised in consultation with an Advisory Committee composed of the engineers of the stations in question; for the pooling of the operating results of the inter-connected municipal stations for the common benefit of the local authorities supplied; and for supplies to or from the Power Coy.'s system on agreed terms. (*d*) Also for providing other necessary powers including the necessary financial powers—subject to the enactment of a further Electricity (Supply) Bill.

Pending the establishment of the Joint Authority, the Commissioners are asking the principal local authority undertakers and the Power Coy. to form a small Provisional Committee with whom they may consult from time to time with regard to any development of supply in the district.

CO-OPERATION BETWEEN MANUFACTURER AND RE-SELLER.

All keen retailers of electrical household utensils realise that there is much business to be done if only consumers of electricity can be made to see how much home comfort can be attained by the general use of electricity for the many and varied purposes for which it is particularly adapted. Such re-sellers, however, find it difficult to carry a stock sufficiently large to meet all demands, particularly in districts where more than one supply voltage obtains, while the cost of arranging a continual demonstration in the use of electrical household appliances is usually prohibitive.

In order to assist in meeting the requirements of the retailer in this direction, the Metropolitan-Vickers Electrical Co., Ltd., is opening up in various centres thoroughly equipped showrooms and demonstration kitchens. Retailers and electrical contractors, by means of an introduction card, can send their clients to these centres to see for themselves electrical appliances of all kinds in actual operation, the sales resulting therefrom being credited to the re-seller concerned.

Such a showroom and demonstration kitchen has recently been opened at 43, Part Street, Bristol, where a comprehensive range of electric fittings is on exhibition in the main showroom. These items comprise simple and elaborate types of electrical lamp fittings, shades and lighting accessories. There is also an array of electric fires, cookers, kettles, domestic irons, jugs and boiling plates, while experts are at hand to demonstrate the use of vacuum cleaners, washing machines and similar applications of the "Silent Servant."

A feature is the demonstration kitchen—completely equipped with every electrical appliance that can find a place in assisting the housewife to run her establishment with the greatest amount of ease and efficiency. Here again, trained assistants give demonstrations in the use of electricity for cooking dinner, baking bread and pastries, washing, ironing and drying clothes, and even in the irksome cleansing of the chinaware after meals.

In general, this new showroom and demonstration centre at Bristol marks a real and practical attempt to educate the British public in the more general use of electricity for household purposes, and the result of this movement is sure to be to the mutual interest of the retailer, the supply authority and the manufacturer.

THE ELECTRICAL INDUSTRY AND UNEMPLOYMENT.

The joint industrial councils of the electrical industry, acting for the cable making, electricity supply, and contracting branches, together with representatives of the assocns. of electrical manufacturers, the wholesalers, and the E.D.A., have discussed the present conditions of unemployment in relation to the electrical industry, and have formulated measures which might be taken to secure restoration of finance and trade within the industry and bring about alleviation of unemployment. As a result practical schemes on behalf of the electrical industry have been submitted to the Cabinet Committee on Unemployment, and were most favourably received.

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SWITCH FUSES.

PATENT PORCELAIN HANDLES FITTED WITH Q.B. LINKS.

W. T. Henley's Telegraph Works Co., Ltd., have recently put on the market a very useful form of quick-break disconnecting link, which consists of a copper link fitted with an auxiliary blade or flipper at both ends, the whole being mounted in a heavy porcelain carrier which is interchangeable with the well-known shrouded fuse carriers manufactured by this company. The arrangement provides a simple means of disconnecting under load where it is impossible to use quick-break knife switches owing to the lack of room. For instance, they are now being largely used in feeder pillars and sub-stations where the saving of space is an important feature. We understand these quick-break disconnecting links (patent No. 102662/16) can be supplied from stock in all sizes from 60 amps. to 500 amps. for use on 500 volt. circuits.

Messrs. Henley's advise us that they are prepared to send a complete sample link for demonstration purposes to any engineer interested, while an illustrated description is given in Messrs. Henley's List W.O.1 (1st edition).

ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to Questions set at the 1921 Examination of the City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page 598.*)

Q. 6.—Make a diagram showing the arrangement of current and potential transformers and watt-hour meters to measure a three-phase supply by means of two single-phase meters. Derive an expression for the average power-factor in terms of the readings of the two energy meters. At what power factor will one meter be stationary?

A. 6.—Instrument transformers are generally used when the current exceeds 100 amperes or the voltage exceeds 600. Current transformers are usually designed for 5 amps in the secondary, whilst pressure transformers generally step-down to about 110 volts. For heavy currents, a current transformer usually takes the form of a solid copper bar supporting but insulated from a laminated iron ring wound with a number of turns of comparatively thin wire. The copper bar is inserted in the main circuit, whilst the secondary winding is connected to the current coil of the meter as shown in diagram.

For high voltages, the pressure transformers are usually oil-immersed and protected by H.T. fuses.

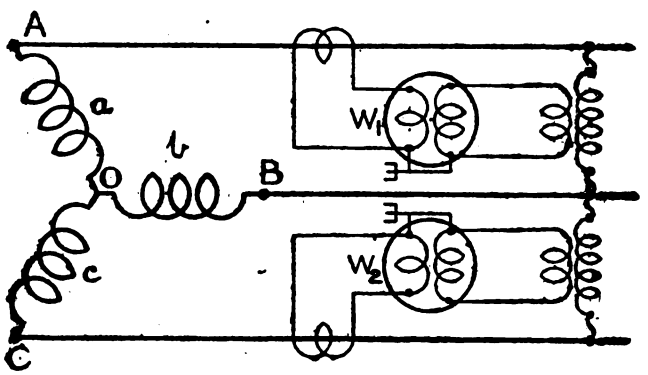


FIG. 9.

The L.T. side of the transformers along with the cores and the tanks should be thoroughly grounded to prevent high potential on the panels in case of insulation breakdown.

Fig. 9 shows the connections of the instrument transformers to two single-phase watt-hour meters for measuring the energy in a three-phase circuit.

If I_A and I_C be the line currents in A and C respectively lagging $\phi°$ behind the phase voltages (assuming star connection of alternator), then the phase voltages and currents are as represented vectorially in Fig. 10. The voltage acting across from B to A in Fig. 9 is the vectorial difference between V_a and V_b and is represented by V_{BA} in Fig. 10; this is the voltage acting across the pressure coil of meter W_1. Similarly V_{BC} is the voltage across the pressure coil of W_2. If t be

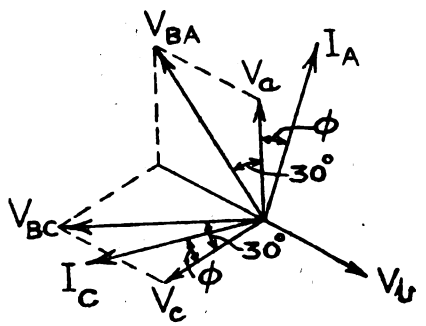


FIG. 10.

the time in hours during which the load is kept on the circuit,

energy registered by $W_1 = w_1 = I_A V_{BA} t \cos(30+\phi)$ watt-hrs.

and energy registered by $W_2 = w_2 = I_C V_{BC} t \cos(30-\phi)$ watt-hrs.

If the load is balanced,

$$I_A = I_C, \text{ and } V_{BA} = B_{BC}$$

$$\therefore \frac{\cos(30+\phi)}{\cos(30-\phi)} = \frac{w_1}{w_2} = r \text{ (say)}$$

$$\therefore \quad r = \frac{\cos 30.\cos\phi - \sin 30.\sin\phi}{\cos 30.\cos\phi + \sin 30.\sin\phi}$$

$$= \frac{\sqrt{3}\cos\phi - \sin\phi}{\sqrt{3}\cos\phi + \sin\phi}$$

$$\therefore \quad \sqrt{3}(1-r)\cos\phi = (1+r)\sin\phi$$

$$3\left(\frac{1-r}{1+r}\right)^2 \cos^2\phi = \sin^2\phi$$

$$= 1 - \cos^2\phi$$

$$\cos^2\phi\left\{1 + 3\left(\frac{1-r}{1+r}\right)^2\right\} = 1$$

$$\therefore \cos\phi = \frac{1}{\sqrt{1 + 3\left(\frac{1-r}{1+r}\right)^2}}$$

Hence the power factor can be calculated from the ratio of the meter readings.

If the load has not remained constant, the *P.F.* thus obtained will be the average value.

It has been shown above that the energy registered by W_1 is given by

$$w_1 = I_A V_{BA} t \cos(30+\phi)$$

If ϕ be 60°, then $\cos(30+60) = \cos 90 = 0$; so that no energy would be registered by W_1. But since $\cos 60°$ is 0.5, it follows that when the *P.F.* of the load

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is 0.5, one meter is stationary. Should the *P.F.* fall below this figure, this meter would rotate backwards, and the reduction in energy registered by it should be subtracted from the energy registered by the second meter in order to obtain the total energy absorbed by the load.

(To be continued.)

BOOSTER AND REACTANCE CONTROL FOR CONVERTERS.

A series of tests, carried out by F. T. Hague, of the Power Engineering Dept. of the Westinghouse Electric and Manufacturing Co. (U.S.A.), and reported in a recent issue of the ELECTRIC JOURNAL, gives much information concerning the relative efficiencies of the booster type converter and the simple converter. It is a costly matter to make these tests with all the precautions needed to ensure reliable results, much testing equipment being required, and the actual expenditure amounting to thousands of dollars in the case of a large converter.

The voltage range of a booster converter is obtained by the "boost" or "buck" of the auxiliary machine, and it has often been stated that the efficiency of the set is lowered seriously by increased load losses when the booster is excited. The results of the present tests disprove this contention, and show that in the case of a 6,000-ampere, 60-cycle booster converter having a voltage range from 230 to 290 volts the stray losses vary by only a few tenths of one per cent. over the whole range of buck and boost. From accurate data on the magnitude of stray losses in a converter armature when working at maximum boost voltage and when working at 30 per cent. full load wattless current, it is possible to make an accurate efficiency comparison between the booster type converter and the simple converter, in which voltage regulation is obtained by drawing wattless currents through an external reactance. The booster is merely an alternating current generator of high performance characteristics, and it is found that the machine efficiencies with booster and reactance control respectively do not differ by more than a few tenths of one per cent. at full load.

The difficulty in verifying this fact experimentally is due to the fact that the stray losses must be determined by taking the difference between the efficiency by the separate loss method and the efficiency by the input—output test. In the latter test it is only necessary to take simultaneous readings of three single-phase wattmeters and the direct current and voltage, but two quantities of the magnitude of 100 (total power) must be necessary in order to determine by difference the losses which are of the order of 5 per cent. The fact that the total losses are so small makes it more important than ever to secure the highest possible accuracy in the readings of power input and output. The main sources of error are: (1) Accuracy and constancy of meters. (2) Reading errors of observers. (3) Load variation or swinging inevitable on all commercial circuits and hardly to be avoided even in laboratory tests. (4) Variations in the no-load losses of the machine. Mr. Hague's tests are remarkable for the success with which these sources of error have been tackled. Specially trained observers must be employed on such tests, and, for several reasons, it is better to use three single-phase wattmeters than a polyphase instrument. The polyphase wattmeter is readily subject to errors in connection on the six-phase diametral circuits used on converters, but mistakes in connections are not likely to occur where single-phase meters are used, and, by using three single-phase meters, observational errors on one phase have a fair chance of being neutralised by the readings on the other two phases.

It is found from the above tests that the full load efficiency of a 60-cycle booster type converter does not vary more than 0.1 per cent. between mid-voltage and the extremes of buck and boost, and at half load the variation is only 0.55 per cent. On 25-cycle supply the stray losses are yet less. Thus, the 60-cycle booster converter obtains its wide flexibility in voltage range and other desirable operating characteristics without sacrifice of efficiency. The stray losses increase disproportionately when the current rises above full load value; also, the converter is essentially a unity power factor machine and must be operated at unity power factor if its full efficiency is to be realised and its operating maintenance kept within low limits.

It is seldom realised that a large proportion (roughly half) of the full load losses in a converter armature are constant and not subject to stray losses. The latter are incident to the losses in three separate parts of a converter: (1) The armature iron. (2) The armature copper. (3) the I^2R loss in the direct current brushes. Due to the rapid increase in stray losses when the current rises above normal full-load value, a converter designed for a certain rating (without overload) cannot be operated with higher current density in copper and brushes without real sacrifice of efficiency.

TELEPHONE LANGUAGE UP-TO-DATE.

(1)

If you find you want a typist, a stenographer or clerk
From a hundred other applicants—SELECTOR.
When you find her at your elbow and your'e going to "try her out"
And you get a closer look at her—INSPECTOR.
If she brags about her competence and quotes certificates
At a hundred miles an hour, then you must—TESTER.
If she understands your lingo and her taking's pretty slick,
Then the best thing you can do is to—INSTALLER,
And CONNECTOR to your Office with a BELL.

(2)

Every time you *think* you want her (and other times as well)
All the energy required is just to—RINGER.
If she doesn't come immediately, don't lose your bally head.
There's no need to get upon your desk and—HOWLER.
She may only be "slow-acting" and "sluggish to the core,"
Or maybe with some Male Jack she is—BUSY.
She's sure to turn up sometime, when she does remember this.
You're a gentleman, so don't—TRANSMITTER CHEEK.
Though you know she knows you know what she's been doing.

(3)

If her movements they are languid and she's always looking bored,
Then for Heaven's sake do something to—EXCITER.
If she's too much of a hustler and rampages like a bull,
Then you've got your work cut out to—REGULATOR.
If she slinks into your office half an hour behind her time,
Be a sport—don't let her think that you—DETECTOR.
But if she gives you impudence and tries to show her airs,
Just assert yourself and—WIPER BACK TO EARTH,
And let her see you mean to SUPERVISOR.

(4)

If some bounder in the office wants to take her for a walk
And she doesn't like his movements, then—PROTECTOR.
If she runs off with your cheque book and forges up your name,
And your bank sends in an overdraft—ARRESTER.
If someone dashes in your office with work no one else will do,
Jerk your thumb towards her door and—INDICATOR.
She may curse you but she'll do it, for she loves the man who rules,
And she's got no time for one who can't—CONTROLLER.
And every time she tries to talk just—INTERRUPTER.

G.E.C.

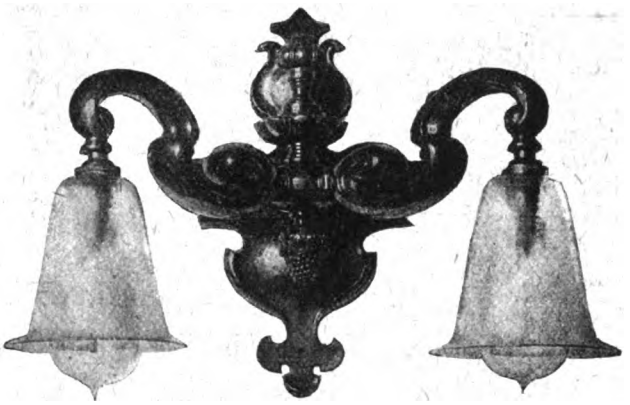
The Electro-Harmonic Society.—The next Concert (Ladies' Night) will be held in the Great Hall, Cannon Street Hotel, on Friday, November 11, 1921, commencing at 8 p.m. Chairman, J. S. Highfield, Esq. (President of the Institution of Electrical Engineers.)

Meetings.—The Junior Inst. of Engineers will meet on Friday, 11th inst., at 8 p.m.—Question and General Discussion evening. On Friday 18, at 7 p.m.—Annual General Meeting. Friday 25, at 8 p.m.—Lecturette: "Electro-Magnetic Instruments,—Problems in their Design and Construction." Demonstrations, etc., by G. F. Shotter (Member). All at Caxton Hall. Also on Saturday, 12th inst, at 2.30—Visit to the Locomotive Sheds of the G.N. Rly. at King's Cross.

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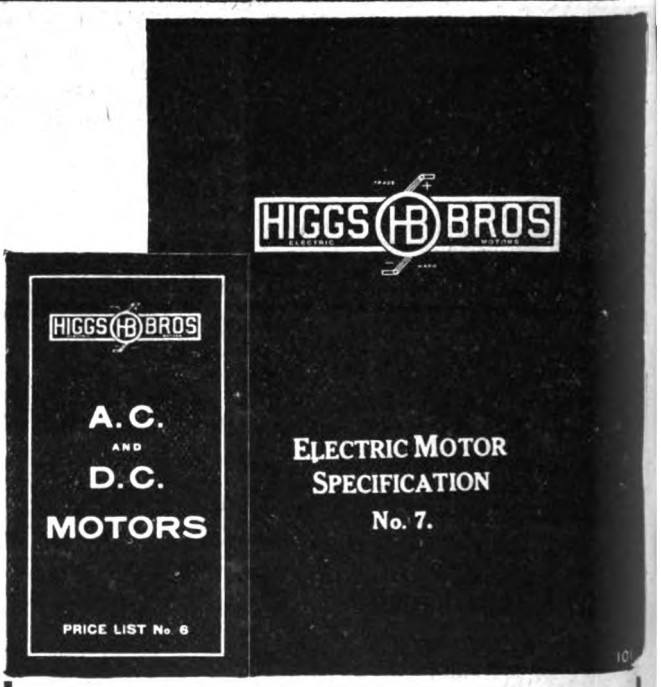
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

The Object Lesson.

The results of the recent municipal elections in the provinces at all events provide an object lesson to the more militant representatives of disaffected Labour. Wherever Labour succeeded in securing a foothold at previous contests, the local expenditure has gone up by leaps and bounds, and rates have risen beyond the capacity of the average citizen to pay. As a natural result Anti-Waste candidates, whether Liberal or Conservative, or any other denomination, had it all their own way at the polls. Personally, I am of the opinion that politics should not enter into municipal contests at all. The object of such elections is to select suitable representatives for the local government of the city or town, as the case may be, and what is really wanted in every case is a Council of good business men, with experience of the public utilities they have to control, and local sympathy with schemes for the improvement of the rateable district.

Unfortunately, good business men fight shy of municipal candidature; they will not face the thankless task of mob oratory, heckling, and public insults which are incidental to most modern municipal elections. Moreover, they have better use for their valuable time than attending Council meetings and wrangling with local busybodies over tramway and street lighting matters, the proper cleansing of the streets, the improvement of slum areas, and similar urgent problems of our modern populous centres. As a result the local busybodies with individual axes to grind have the field pretty much to themselves when November comes along, and of late years the extremists of the Labour party, who do not really represent the general opinion of the average working man at all, have been able to capture quite a respectable number of seats, and have used their temporary power to best advantage during their term of office.

However, public opinion is bound to find practical expression sooner or later, and the recent elections with their results are a case in point. Incidentally, it is significant of the fact that the saner elements in Labour circles are beginning to assert themselves, that at one Northern meeting, when a candidate was asked by one of the crowd, "Why are we unemployed?" and aptly retorted, "Because you have had over 2,000 strikes in two years," his reply was received with marked approval by a large gathering, in which the unemployed element largely preponderated. It is also a healthy sign that the Labour representatives at a recent important conference in London, sitting to consider how best to bring about a revival in the electrical industry, expressed their willingness to co-operate in any schemes and to encourage the workers they represented to put forward their best endeavours to that end.

In the circumstances, and seeing that the various schemes for reviving trade now being considered by the Government are calculated to benefit the electrical industry in general, it is doubly unfortunate that Mr. W. J. Webb's official pronouncement in the official organ of the E.T.U. should constitute a direct appeal to all electrical workers to abolish the capitalistic system and revert to "chattel slavery." In short, Mr. Webb advises his readers to follow the example of Russia and adopt Bolshevism, with all its proved drawbacks and miseries. Surely trades unionism in general and electrical trades unionism in particular is worthy of saner and more intelligent precepts than those emanating from the headquarters of our very own Union. As the premier and most modern branch of the engineering industry it is up to us to set an example to the rest of the industrial community, and this is decidedly not the kind of example needed at the present time.

Too Much Talkee Talkee.

It is very unfortunate that progress to-day depends so much on preliminary oratory. Our very Government is founded on oratory, and the man who can make a rattling good speech, or face any sort of a crowd, and deliver an address on a given subject, is almost sure to make good, whether he knows his subject or not. On the other hand, the capable man who can do things, or get things done, is very often a poor or indifferent speaker, troubled with stage fright and incapable of stringing half a dozen words together effectively when faced with an audience. As a result, there is far too much preliminary speech-making, conferences, and political discussion over every new scheme put forward for the amelioration of our national life.

The new Government scheme for guaranteeing certain important railway electrification and tube extension plans is a case in point. Unemployment is rife; it is one of the most pressing and distressful problems of the day, yet the House is still debating the preliminaries when a prompt start could be made to-morrow if they once gave the word to go. One can quite understand that where public expenditure is concerned every care is necessary to safeguard the public interest, but here we have a scheme put forward by some of the leading railway authorities which does not call for the actual expenditure of a penny piece by the State, only certain straightforward guarantees in the matter of competition, which any trading corporation has a right to expect before it risks its shareholders' money. Let's cut the cackle and get on with the job.

JOHN E. RAWORTH & MOSS,

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Contracts.

We are all interested in finding a way out of the present trade impasse created by high manufacturing costs and topsy-turvy exchanges. To suggest that our workers should labour twice or three times as long as the German workman in order to secure equivalent output on a value basis, or that they should accept very much lower wages for the same working hours when the cost of living remains at the present level, are obviously absurd proposals. The British workman must live, and live decently if he is to do good work and maintain the quality of British goods. At the same time, we cannot hope to regain our industrial supremacy in the face of such one-sided competition unless we make some concession by way of a compromise, in order to attract once more that share of export trade which is now going to those countries where the exchange is so materially in favour of the worker.

In this connection a rather novel suggestion is made by one of my contemporaries, *Engineering Production*. Briefly, the scheme is as follows: Assume that a certain contract is to be let, and judicious negotiation elicits the fact that it can be secured at a maximum figure of £10,000, of which sum, say, one-third would ultimately accrue to the actual producers in the form of wages. The particular employees interested should be acquainted with the facts, and their individual shares in the wages allocation worked out in accordance with their respective participation in the work to be done. With the offer of the job at so much, each man would be in a position to say whether he was prepared to undertake his share at the price available, and it would then rest with their co-operative effort to get the contract executed in as short a time as possible, thus ensuring a proportionately higher rate per man per hour or per day as the case may be. If circumstances were favourable the estimated time for such a job might be well beaten to the men's benefit, or, if exceeded, the corresponding loss offset against a similar contract executed subsequently. Although founded on payment by results, so obnoxious a principle to the Labour extremist, the scheme has much to recommend it by way of an attempt to revive industry.

Motor Car Headlights.

In this issue a summary is given of the third interim report presented by the Departmental Committee on Lights on Vehicles. This report goes a considerable distance further than the previous ones issued by the Committee, and its conclusions are broadly similar to those arrived at in recent discussions before the Illuminating Engineering Society and other bodies. Everyone will admit that the complete elimination of glare is extremely difficult, and the Committee have probably done wisely in not recommending very detailed legal regulations. The authoritative endorsement of the conditions to be aimed at in an ideal headlight should have a good effect, and the plan of issuing certificates to approved forms of headlights seems a good one. The whole question is naturally one of personal interest to motorists as well as to the general public, and there is no doubt that the leading motoring associations will use their influence in the direction of preventing dazzle now that the requirements to be fulfilled are more explicitly stated.

ELEKTRON.

AUSTRALIA.

Australia is endeavouring to stimulate manufacturing enterprise within her boundaries by high customs tariffs; the proposed duty on electrical appliances is 30 per cent. *ad valorem* British preferential, and 40 per cent. general, and, as Mr. S. W. B. McGregor points out in his report on the economic and commercial situation (H.M. Stationery Office, 2s. 9d.), the manufacture of electrical machinery and goods is at present in its infancy, but developments on a fairly large scale are pending. Important British interests are rightly associated with the development of the electrical industry in Australia, but it remains to be seen to what extent complete apparatus can be produced in Australia in a highly-specialised industry depending for economic success on mass production and continued adoption of improvements which naturally originate in the large centres of production.

This development necessitates a supply of labour of the right kind, equitable conditions and the provision of cheap electrical energy. To the latter end the Commonwealth Government is proceeding with comprehensive hydro-electric developments in conjunction with the electrical development of the brown coal deposits of Victoria. The Victorian Electricity Commission, being composed of business men, appreciate the necessity of low capital cost to enable the electrical supply to be cheap, but, according to what we read in the Press (the *Industrial Australian and Mining Standard* has recently been dealing fully with the question), it appears that a large number of the population is obsessed by the idea that all the necessary plant should be manufactured in Australia, whatever the cost, as a means of relieving unemployment, which is as bad in Australia if not worse than it is here. Apparently, even the £100,000 for turbo-generators to C. A. Parsons and Co., and the £17,850 for coal handling plant to Fraser and Chalmers' Engineering Works are grudged.

Economics are apparently less understood by the Australian masses than by those in the islands, and, judging by what we read, we should imagine that, instead of prosperity and the turning of Australia into a large manufacturing country, it is more likely to lose the benefits of a fairly promising start, and slide back to a species of barbarism.

THE "SKATOSKALO" BOILER SCALING TOOL.

For the removal of hard scale in boilers, the "Skatoskalo" patent pneumatic scaling tool is a device which has proved successful in practice, and some details may therefore be of interest. The tool is made in types suitable for every make of boiler, as well as for the purpose of removing encrustations and rust from all iron and steel work.

The fundamental principle of most of the types is the provision of a piston (or pistons) with staggered head worked by compressed air so as to deliver blows on the scale at the rate of about 10,000 per min.

Owing to the sharp cutting edges of these pistons and the tremendous vibration caused by the blows, the scale is rapidly removed without damage to the material operated upon.

The following are particulars of some of the types:—

Type "A" is suitable for Lancashire, marine, loco boilers, etc. It is a hammer-shaped tool with staggered piston and outer shell, and requires an air pressure of about 60 lb. per sq. in., and is also adapted for scaling flat surfaces and for removing rust from iron and steel work. The piston is fitted with a removable bush, so that when worn replacement is an easy matter. An alternative

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chisel-shaped piston can be also used with this tool, and has the advantage that it can be dug right into the scale wherever the encrustation is particularly heavy.

For scaling water-tube boilers, type "E" is made in various sizes according to the diameter of tubes, and consists of a cylindrical body with three pistons arranged so as to act directly on the face of the scale. After inserting the tool in the boiler tube the compressed air is turned on, and the three pistons deliver blows with great rapidity. The tool is moved up and down the tube as required.

Type "F" is specially designed for the removal of scale from the outside of fire tubes, and consists of a cylindrical body with a double-acting vibrator. The vibration caused by this (10,000 blows per min.) rapidly removes the scale, leaving the tubes clean and undamaged.

Type "B" has been designed for removing scale and other deposits from curved or bent tubes. It follows somewhat the principle of the "E" type, but has all its three pistons in the same plane. It is fitted with a ball joint, and the fact that this latter is attached to a flexible air supply gives this tool a wide radius of action. We understand a firm of transformer manufacturers have used it with success for removing rust from the inside of transformer tubes previous to assembling.

Type "R" is for removing carbon from retort pipes, etc. It is fitted with three pistons and is of special value in large pipes where deposits are heavy.

The angle tool type "A.A." is a development of type "A," but, as its name implies, it can be worked at a great variety of angles. It is fitted with a special chisel-shaped head, and is especially valuable for removing rust and scale from nooks and corners which could not be reached conveniently by hand.

Full particulars can be obtained from the maker, Mr. Frank Gilman, Wilders Drive, Warwick Road, Birmingham.

MOTOR-CAR HEADLIGHTS.

A Third Interim Report has just been issued by the Departmental (Ministry of Transport) Committee on Lights on Vehicles. The Committee has continued its study of the allied problems (1) the conditions constituting dazzle, and (2) the requirements of a safe driving light. The prevention of dazzle under all circumstances is regarded as impracticable; in many cases, however, dazzle is due to faulty adjustment of lamps. Over one hundred lamps and devices to avoid dazzle have been tested. Many show great merit, but none fulfills completely the conditions demanded in an ideal headlight. Such conditions are outlined in an appendix to the report. The main beam should have (*a*) a minimum range of 150 feet and a maximum of 300 ft., (*b*) a minimum width of 30 ft. and a maximum height of 4 ft. from the ground at 150ft. from the lamp, (*c*) the lower edge impinging on the read not more than 50 ft. from the headlight, (*d*) the field free from dark patches and reasonably uniform illumination or good gradation. In addition to the main beam there should be a field of diffused light with a forward range not less than 50 ft. or less than 25 ft., with a lateral divergence at the road surface of at least 20 ft. at a distance of 5 ft. forward from the face of the lamp. Particulars of the R.A.C. disc for testing illumination are also given.

These conditions are put forward as an indication, and not as regulations. The Committee consider, however, that regulations restricting dazzle to a modified extent should be laid down on such lines as to permit of the use of existing lamps if adapted, by the use of frosted glass, etc., to diffuse light above a height of 4 ft. from the ground. It is not considered practicable at present to prescribe minimum illumination as compulsory, though one of the members (Mr. W. G Howard Gritton, M.P.) dissents from this conclusion.

In any case compliance with regulations will demand the co-operation of makers of lamps and motorists, as their enforcement by the police will present difficulties. It is also suggested that manufacturers should be able to submit lamps to official organisations and authorities who would be empowered to issue certificates of approval.

Other comments refer to swivelling headlights, which should not be permitted, although lamps may be tilted downwards in order to mitigate dazzle provided that all headlights move simultaneously. Inspection lamps are permitted provided they are only used when the vehicle is at rest.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 128.

Is it possible to measure the insulation resistance of a three-wire system without interrupting the service? If so, will you please explain to me how this would be done.—"TESTER."

QUESTION No. 129.

I wish to make an electric kettle for use on a single-phase, 230 volt supply. I would appreciate any details that will enable me to do this.—"JOINTER."

(*Replies to Questions Nos. 128 and 129 must be received not later than November 26, 1921.*)

Answers to Questions.

QUESTION No. 125.

How would you calculate the number of turns in the stator windings of an induction motor? It is presumed that a few of the factors are known, such as speed, voltage, frequency, etc.—"S. H. ADAMS."

REPLIES TO QUESTION No. 125.

The first prize (10s.) *has been awarded to "D. J. Wilson" for the following reply:—*

It has been decided to deal with the stator design of a 40 b.h.p motor, 750 revs. (synchronous speed), frequency 50 cycles per sec., three-phase, star connected, suitable for operation on a 550 volt system

The particulars supplied are scanty, so that it is necessary to plot the equation

$$C = \frac{b.h.p.}{d^2 l \times r.p.m.}$$

from examples in practice, by plotting C vertically and *b.h.p.* horizontally.

b.h.p. = brake horse-power.
r.p.m. = revs. per minute.
d = dia. of stator bore.
l = length of stator core.

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From such a curve the value of C must be interpolated, which in this case will be, say, 0.000019. From this the stator bore can be determined since we know the speed and output.

If $C = \frac{b.h.p.}{d^2 l \times r.p.m.}$ then $d^2 l = \frac{40}{0.000019 \times 750} = 2,806.$

All manufacturers have stock sizes of laminations, so that it is just a matter of selecting a suitable diameter and building up to the required length. We will use stator laminations with a core diameter of 16.75 inches. With an all-round air gap of 0.030 this will give us a rotor diameter of 16.69 inches. Allowing, say, 10 per cent. for the insulation, this gives a length of 10.9 inches.

Frequency $= \frac{r.p.m.}{60} \times \frac{\text{No. of poles}}{2}$, so that the required number of poles is 8.

Stator pole pitch $= \frac{\text{Circ. of stator bore}}{\text{Number of poles.}}$ and substituting we get that the stator and rotor pole pitches are 6.578 inches and 6.555 inches respectively.

Generally speaking, with the stator the number of slots per pole per phase is three, which, in an eight pole machine means 24 slots per phase, in all 72 slots.

The number of slots is usually higher in the rotor than the stator, and must be so chosen as to have no common factor in order to avoid "cogging." Unfortunately this is impossible in 3-phase wound rotors.

The makers' standard also help to select the number of bars in the rotor.

The flux in the air gap must be assumed; for normal conditions this will vary from 20,000 to 25,000 lines per square inch. In considering the gap area we average the area of the stator and rotor pole faces, less, of course, the slot openings in each case.

In our case the area of the stator pole face is 55.78 square inches and that of the rotor 54.3 square inches, which gives an average of 55.04 square inches.

By assuming a value of 21,750 lines per square inch, we have a total flux of $21,750 \times 55.04$ lines.

The formula for induction motors is:—

$$E = \frac{4.44 N \times t \times f \times k}{10^8}$$

Where E = back *e.m.f.* per phase.
N = total flux.
t = number of turns per phase.
f = frequency of system.
k = distributed winding factor value 0.95.

If we assume a stator copper loss of, say, 5 per cent., the value of E will become 303 volts. By transposing we get

$$\text{Number of turns per phase} = \frac{E \times 10^8}{4.44 N \times f \times k}$$

$$= \frac{303 \times 10^8}{4.44 \times (21,750 \times 55) \times 50 \times 0.95} = 120 \text{ turns.}$$

The number of conductors per phase is therefore $120 \times 2 = 240$. It is essential that this number be divisible by the number of slots per phase, in this case 24.

The value of B must be corrected and the number of turns re-calculated if the number of conductors is not divisible by the number of slots per phase.

The current taken by a three-phase motor is given by—

$$C = \frac{746 \times b.p.h.}{3 \times V \times Cos\,\phi \times \eta}$$

Where C = current.
$b.h.p.$ = brake horse-power
V = phase voltage.
$Cos\,\phi$ = power factor, say 0.85.
η = efficiency, say 0.87.

from which $C = 42$ amps.

The output in watts $= 40 \times 746 = 29,840$, so that with an efficiency of 87 per cent. the input will be 34,300 watts. This makes the stator C^2R loss 572 watts per phase and the resistance per phase (hot) $= 572/42^2 = 0.3243$ ohms.

The coils must next be carefully drawn to scale and the length of wire required per phase carefully estimated. From a wire table we then find a suitable diameter which, when of the required length, has a resistance of 0.3243 ohms when at a temperature of, say, 40° Cent. The dimensions of the slots is next determined, allowing for 10 wires and slot insulation, but here again stock sizes may assist.

Throughout the design the thing to do is to make use of standard size punchings, slots etc.

D. J. WILSON.

The Second Prize Winner's reply will be published in due course.

MARKING TOOLS BY ELECTRICITY.

With a view to enabling tools to be marked easily with identification letters, with the name or number of the machine or shop to which they belong, or with the name of their owner, the A.E.G. have placed on the market a simple equipment by which any desired lettering or wording can be inscribed on any metal article in ordinary characters and at the speed of ordinary writing. A small transformer of about 1 kw. rating is used to supply alternating current at about 1.5 volts on the secondary side, the primary being wound for any pressure up to 500 volts. One secondary terminal of the transformer is conntected to a metal table on which lies the tool, etc., to be marked. The other secondary terminal is connected by flexible cable to a pointed electrode which is used for "writing." This electrode is carried in a water-cooled handle; it is easily renewable, and can be sharpened by filing before renewal becomes necessary. Six tappings are provided in the transformer winding so that the secondary pressure can be regulated to suit the size and depth of the characters to be inscribed.

When the movable electrode is brought into contact with the tool lying on the fixed electrode, the local heating produced (as in point-welding) causes the metal of the tool to be melted to a small depth. Naturally the "pen" is not allowed to stick to the work, and the depth of the characters formed is regulated by the tapping used and by the manipulation of the movable electrode.

Compared with etching and stamping, which are alternative methods of marking tools, the new process is quicker and simpler. It avoids the risk of error which so often creeps in where separate metal stamps are used and it avoids the shocks imposed by the use of stamps. In particular, the sharp cuts formed by stamps are very liable to initiate cracks in hardened metals, and the risk is quite obviated by the electrical process. Etching is a messy process which generally involves more or less damage in places where marking is not required. The average power consumption of the new equipment is said not to exceed 400 watts.

Electro-Plating and Electro-Deposition.—The full report of the Symposium and General Discussion on the above, held by the Faraday Society (10, Essex Street, W.C.2), at Sheffield, in November, 1920, can be obtained for 10s. 6d.

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THE LIGHTING OF COVENT GARDEN MARKETS.

Covent Garden Markets comprise a number of separate buildings and areas. The Central Market is well known to most Londoners and is an object of interest to many visitors, mainly owing to its central arcade with its retail shops for flowers and fruit. The Markets also comprise the Potato and Apple Markets, the Foreign Fruit Market, the Flower and Foreign Flower Markets, the Russell Street Market and the areas outside where the vans are unloaded.

The lighting of this large area has passed through many phases, oil lamps, flat flame gas burners, incandescent gas mantles, a certain amount of high-pressure gas lighting, put in some seven years ago, and a restricted amount of electric lighting by means of carbon and—later—metallic filament lamps. On the conclusion of the war Messrs. Handcock, Dykes and Trotter were requested to prepare schemes and estimates for both high-pressure gas and electric lighting. Careful photometric measurements of the actual illumination showed that this varied greatly, the minimum being 0.23 foot candles at 3 ft. 3 in. above ground level. Finally it was decided to aim at an illumination of 1½ foot candles for the selling parts of the Markets, say a range from 2 foot candles to one. Detailed schemes were worked out, and after full consideration of the report, the Directors decided to light the whole of the Markets electrically. Specifications were accordingly prepared in detail and ultimately a contract was placed with the Alliance Electrical Co., Ltd., of King Street, Covent Garden, W.C.2.

Great stress was laid by the Directors on the necessity for taking all possible precautions against any portion of the markets being left in darkness owing to blowing of main fuses or any cessation of supply. Accordingly each section is provided with duplicate services from the mains of the Metropolitan Elec. Supply Co., Ltd., these services being taken off different mains. The pressure is 200 volts. Half the lights in each section being on each service, the blowing of a service fuse can at most only extinguish alternate lights. In addition, the lights on each service are sub-divided into police and working lights, all controlled from one central point. This sub-division and the requirements of control from one centre have necessitated a large number of circuits and switch control mains.

The system of wiring adopted comprised the running of braided aerial cables overhead down the length of the Markets, these cables being supported on insulators threaded on to steel span wires or on crossarms clipped to the down rods of the old gas pendants, the rest of the wiring on the walls and up to the ends of the overhead mains being heavy sheathing "Stannos," which, owing to the facility with which it can be installed, the freedom from any condensation troubles, and its resistance to corrosion arising from atmospheric conditions was calculated to meet the requirements of the case. The ends of the "Stannos" wires are soldered direct on to the cases of the fuse boxes, the other ends terminating in cast iron boxes whence connections are made to the overhead wires.

The interior fittings are mostly enamelled reflectors carried either on span wires, or where available fixed on to the down rods of the old gas lanterns. The lighting of the outside of the Markets is carried out by means of "Stannos" wires clipped to the face of the stonework, making a very neat and inconspicuous job and one capable of withstanding all weathers. The lamps range in power from 100 to 500-watts and are of the gasfilled type carried in open reflectors. The outside areas surrounding the Markets are lit by means of 500-watt gasfilled lamps suspended over the streets on steel suspension wires fixed to steel masts or to the sides of the buildings. The general effect of the lighting is very good and the salesmen have testified to the improvement.

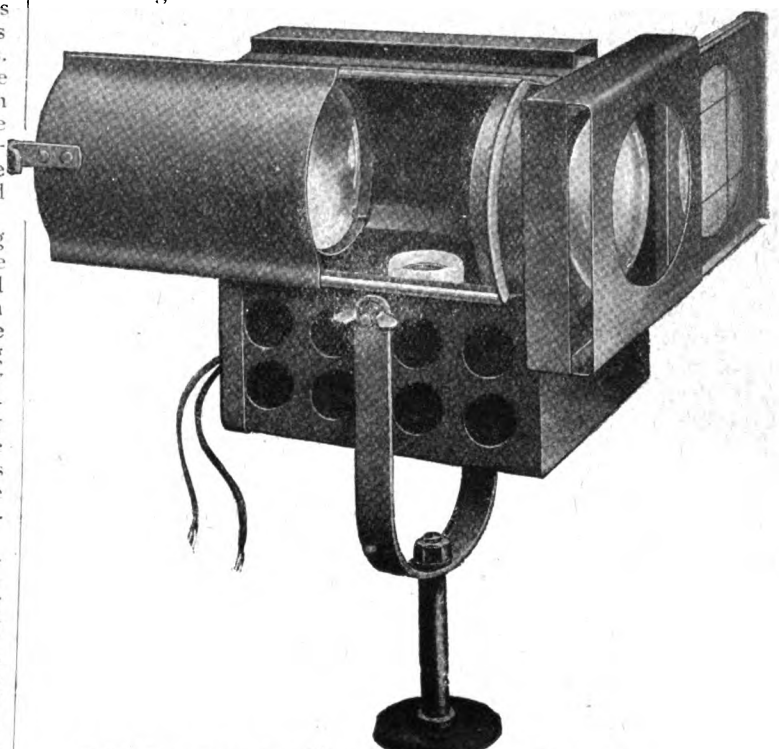
The work was attended with some difficulties owing to the large amount of traffic through the Markets, and to the fact that the ordinary business had to remain uninterrupted during installation. Further it may be of interest to state that the longest run from switch to lamps is 105 yards and that, in order to avoid joints, the "Stannos" wire had to be supplied in specially long lengths of over 100 yards. Over 10 miles of "Stannos" wire, 6½ miles of aerial wire, 300 gross of "Stannos" "butterfly" clips and 16,000 Rawlplugs have been used on the work. The whole of the "Stannos" material was supplied by the manufacturers of the "Stannos" System, Messrs. Siemens Brothers and Co., Ltd., Woolwich.

Some months after completion, the installation was tested for insulation, when the following satisfactory values (resistance in Megohms) were obtained :—

Lights	Markets. Central.	Flower.	Jubilee.	Russell St.	Floral Hall.
"A" Police	12	12	25	10	25
"A" Working ...	9	9	20	9	20
"B" Police	15	20	20	9	25
"B" Working ...	9	8	20	12	20
Pilot	16	20	7	—	—

THE "BABY SPOT" PROJECTOR.

The illustration shows the new B.T.-H. projector for use with gasfilled concentrated filament lamps. Although designed primarily for theatre lighting, the "Baby Spot" is most useful for spot lighting of special articles in store windows and for the illumination of cinema corridors, clock faces, indicators, small posters, signs, etc. The body is strongly constructed of sheet steel, the mirror glass reflector has a copper back and reflects the light to the 4 in. dia. plano-convex lens, so that combined with the light received on the lens direct from the lamp a strong parallel beam of light is obtained.



B.T.-H. "BABY SPOT," WITH SIDE OPEN, SHOWING MIRROR AND LAMPHOLDER, COLOUR SLIDE PARTLY REMOVED.

By loosening the wing nut on the underneath portion of the body, the lamp can be moved forwards or backwards according as a "spotting" or "flooding" effect is desired. This wing nut secures both reflector and lamp in any desired position. The apparatus is extremely compact, and is well ventilated. A slide is fitted in front of the lens so

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that colour mediums may be used, and by a single operation the colours can be changed as desired in a few moments.

Further information will be furnished by the B.T.H. Illuminating Engineers' Dept., Mazda House, 77, Upper Thames Street, London, E.C.4.

SUBMERSIBLE ELECTRIC MOTORS FOR MINE'S PUMPS.*

By A. J. Ramsay.

(*Continued from page* 613)

In order to ensure that a good earth contact is made between the two half-casings, three flat copper strips fixed in equidistant positions around the plug half spring into suitable seatings on the other half-casing. The joint between the two halves is made on a flat-machined surface with a packing washer, which is pulled tight by a stiff locking-nut. Covers are provided for protecting the contacts when not in use. A stuffing box is fitted at the neck of each half-coupling, which serves the double purpose of making the interior watertight and of relieving the cable connections of mechanical stress. In cases where the cable armouring is used for earthing purposes, a modification is necessary at the neck of the coupling, and such an arrangement will be described later in connection with a large pumping set for sinking work. The insulating block is provided with a locating feather which is in a fixed position with reference to the exterior feather.

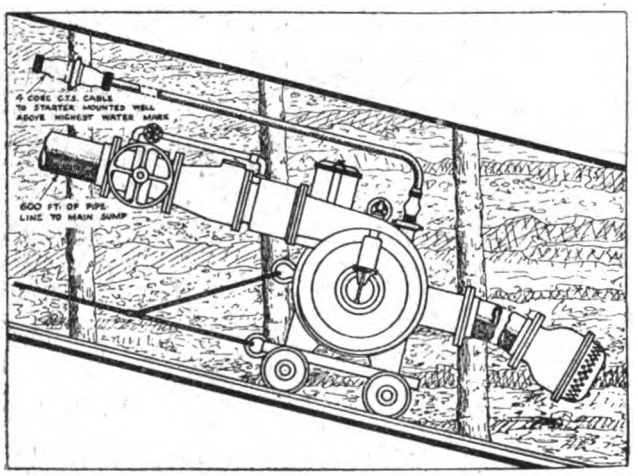


Fig. 5.—Portable Dip Pump.

Fig. 5 is a drawing of a 6in. double-inlet pump coupled to a 50-h.p. motor installed in a mine in Gloucestershire for use in "dip" workings. The set, as will be seen, is mounted on a trolley. Fig. 6 gives the curves of the motor pump taken on test.

De-Watering Shafts.

From the description given it will be agreed that the submersible motor pump is eminently suitable for pumping out shafts and pits. The following additional advantages may be briefly stated:—(1) The whole unit may be submerged, thus eliminating the necessity for suction pipe and foot valve, with the attendant losses and troubles on the section. (2) Great saving in time and labour, as delivery pipes and feeding cable can be fitted in one operation, providing for a lengthy run before it is necessary to shut down again for adding additional lengths.

*Abstract of paper read before the North Staffordshire Inst. of Mining Engineers and first published in *The Mining Electrical Engineer.*

As an example of what may be accomplished, an operation carried out at an old mining shaft will be described. It was necessary to find in this case the yield of the shaft at a depth of 300ft. from the surface, the shaft being about 500ft. deep and 12ft. in diameter. A suitable high-lift pump in one unit was not available at short notice, and it was decided to use four 6in. sets coupled in series, each of which was to be of the capacity and design of the set already described in detail. The motor pumps were coupled together in pairs, with the delivery of the first bolted direct to the suction of the second.

A start was made by lowering the first pair to a depth of about 150 ft., the water then being within 11 ft. of the surface. In five days the water level was lowered to the level of the pumps, and then the second pair were joined in series and the whole lowered, so that the bottom pair were about 310 ft. down. After a further seven days the water-level was lowered to 275 ft. from the surface, and a continuous yield of about 33,000 gallons per hour was obtained at this level. Altogether the plant was running for 37 days, one pair running for 24 days on end, and on 19 of these days for 24 hours per day.

The bearings of these machines were all fitted with automatic lubricators in the form of a cylinder mounted at each end of the machine, with a pressure-pipe connection entering the top of the cylinder. Mining engineers will appreciate the difficulties which had to be overcome in lowering plant into an old shaft such as this, with unknown projections obstructing the gear and quantities of debris of all descriptions in the shaft. The only pipe line available

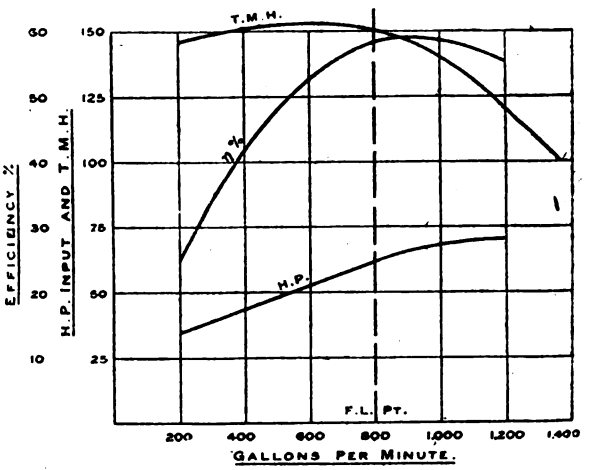


Fig. 6.—Performance of 6-inch Double-Inlet Motor Pump.

was a screwed-joint M.S. tube, and this was clamped in sections together with the feeding cables to the single-suspension wire rope. A short length of flexible pipe was fitted on the suction side of the pair nearest the top in order to compensate for varying lengths in suspension. No other machine known to the author could have been used in such a manner, and the necessary information was obtained without the expense of the provision of special plant for the purpose of obtaining the yield of the shaft.

Pumping at Pengam Colliery, Monmouthshire.

A further example of the de-watering carried out at Pengam Colliery entirely with portable generating and pumping plant will now be given. The old pit at which operations took place is situated in a valley at such a level as to drain the water from the workings in the hillside, the shaft being about 8 ft. in diameter and 120 ft. deep. The electric supply was not laid on when operations commenced, and use was made of a paraffin-oil engine driving an alternator supplying 35 k.v.a. at 220 volts, three-phase.

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and 50 periods. The arrangement included a switchboard containing a voltmeter and ammeter, and a three-pole fuse switch of the ironclad type. Connection was made from the switch to an auto-transformer starter and thence by three-core C.T.S. cable to the motor pump. The 6 in. motor pump used was of the same duty as previously described and was fitted with automatic lubricators. The pump was suspended during the whole operation by a wire rope.

Pumping was commenced on May 6, 1920, and the motor pump was removed on April 13, 1921, when it was replaced by another submersible motor pump of larger capacity. Altogether the pump ran for 281 days, with an average of 19 hours per day, although the pump very often ran for weeks together for 24 hours per day. The average working head was 60 ft., and the quantity of water delivered 60,000 gallons per hour. The machine was brought to the surface twice for examination during the summer of 1920, and was found to be in perfect condition. For the last six months of the period of working the motor pump was entirely submerged, and no examination of any sort was made. Such a performance for an electrical machine the author believes to be without parallel.

The set was returned direct to the works, after being raised on April 13, 1921, and the following is a brief report of the condition of the machine :—

Insulation test of motor windings, in water : 8 meghoms.
Bearings : In good condition.
Grease lubricators : Thrust end nearly empty and housing full ; motor end half full and housing full.
Shalf : In perfect condition (as there are no tight-fitting glands).
Machine coated inside and out with red sand deposit.

A rough wooden platform was built over the machine, and this was used by sinkers in the summer of 1920 as a platform when working down below. A considerable amount of sinking work was carried out with the aid of this pump, and the sinkers engaged on the work expressed surprise at the lack of trouble with the pumping arrangements, which they stated was quite an exceptional experience. In a small shaft such as this it was found a great convenience to have the pumping plant beneath them, and thus have provided the maxiumm space for lifting buckets, etc.

(To be continued.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]*

ELECTRICAL TRANSMISSION OF ENERGY. By W. M. Thornton. 116 pp., 49 figs. (*Pitman*, 2s. 6d. net).—This is one of the latest additions to Pitman's Technical Primer Series, and, as is to be expected, the distinguished author presents his treatment of the subject in a most understandable manner. The title by itself is apt to induce an expectation of different contents to what we find. The sub-title is necessary. It is "a survey of the physical basis of electrical transmission; its methods and phenomena from the standpoint of the electron for students and practical engineers." It should be understood, however, that no alteration of existing practice is foreshadowed, but the theory does explain in a most intelligible manner various phenomena. It embraces a consideration of conductors and insulators, thermal and electrical conductivity, ionisation, electrical discharges, the grading of cables, dynamo electric machinery, oil break switches, etc., as well as surges and other transient phenomena. The book is based on notes forming the substance of six informal lectures to the members and students of the Inst.E.E. in Newcastle and Middlesbrough, together with some additional notes on transient phenomena. As previously mentioned the theory is presented in a most understandable manner, and it is most desirable that all engineers and scientists should be in possession of its outlines as here given. Most practical men will be satisfied with Dr. Thornton's account of the nature, shape and behaviour of electrons, but for those desirous of pursuing their studies further the Bibliography on page 111 will be of much assistance.

ELEMENTARY TEXT BOOK ON MOTION PICTURE PROJECTION. By J. R. Cameron. Theatre Sup. Co., N.Y. 140 pp. illus. (Rentell, 8s. net.)—This volume, prepared for the instruction of crippled and disabled men in the Red Cross Institute (New York), is evidently based on the author's *Motion Picture Projection* (21s. net), and consists of an abridgement of the larger work. Naturally it is not so complete as the latter, but it gives a very good introductory treatment of the various subjects on the same lines. Undoubtedly it is more easily digested by the beginner than would be the case with the larger book, but, on the other hand, every successful beginner develops into an operator who requires an exhaustive treatment of the subject. For this reason we should recommend readers to purchase the larger book in the first instance.

MOTION PICTURE PROJECTION. By J. R. Cameron. 559 pp. illustrated. Theatre Supply Co., New York. (Rentell, 21s. net.)—This book gives a sound treatment of the main facts, principles and practice in all branches of motion picture projection and kinematograph theatre operation. Glossaries of electrical, mechanical and kinematograph terms are followed by pages devoted to the principles and laws of electricity, and of electrical circuits and testing as relating to kinematograph installations. The projection room and the lay-out of the theatre from the point of view of projection are then considered, a number of clear diagrams being included.

An excellent perspective sketch is given explaining the working principle of projectors and a number of pages are devoted to light and the principles of optical projection. In our opinion this section might well be extended, as lenses and optical projection form the essence of kinematography from the projection point of view.

Electric time systems are described for maintaining a predetermined running schedule and synchronising music with pictures. Portable and standard projectors are described in great detail, all the component parts being excellently illustrated. The machines described are, of course, American.

Though rather short, the treatment given to ventilating, heating and cooling of theatres is very useful indeed. This is an important subject on which little literature is available for the operator.

Arc control mechanism, transformers, economisers, etc., are all dealt with adequately and there are some useful pages on motor troubles and remedies. Good practical information is given concerning screens and the Griffith system of colour kinematography is explained.

A large section of the book is devoted to detailed instructions for the operation and maintenance of various types of projectors and of petrol-electric sets, accumulator batteries, motor-generators, etc. Useful tables are included and there is a good collection of questions and answers which will enable the reader to test his knowledge. Though not applicable in this country, the rules issued by various American authorities (reproduced in this book) are useful for reference purposes and convey indirectly a considerable amount of information. With the exception of some illustrations which might be improved, the book is very well produced and we recommend it to the attention of our readers.

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E.D.A. SALESMANSHIP CONFERENCES.

The British Electrical Development Assocn. has arranged a series of about six meetings on the subject of salesmanship in relation to the different aspects of the domestic load. This series will be held at the Chartered Institute of Patent Agents (Staple Inn Buildings, W.C.1), the first meeting taking place on Friday next, the 18th inst., at 8 p.m., when Mr. E. H. Freeman, M.I.E.E., will speak on "Salesmanship in Wiring and Installation Work," under the chairmanship of Mr. S. T. Allen, M.I.E.E. The proceedings will not be open to the general public, but qualified persons can obtain admission by tickets to be obtained from the E.D.A. offices (Hampden House, 84, Kingsway, W.C.2). Doubtless this movement for the consideration of methods of popularising the use of electricity, and presenting the advantages of electrification to the consuming public will spread to the provinces, where similar meetings in suitable centres could with advantage be held.

A BIG STUNT.

Excellent as have been past publicity efforts to popularise electric lighting, there is no doubt but that this season the domestic consumer—and potential consumer—is having the advantages and benefits of electric light more tellingly brought to his notice than on previous occasions. First there is the E.L.M.A. scheme of general publicity, already referred to in these columns, and secondly the comprehensive schemes which all manufacturers are embarking on. Some particulars of several of these likewise have already appeared in this journal. The latest scheme, of which full particulars have reached us, is that of the General Electric Co., Ltd., on behalf of our old friend the Osram, ever young, as he is kept right up-to-date with the march of progress. The G.E.C. has never been accused of tackling Osram publicity in a niggardly spirit, and in the present season's campaign we should imagine that previous efforts will be outstripped—at any rate that is the impression conveyed by a 24 large page brochure in which full details are given of the national advertising scheme just commencing.

Further, it should be noted that by the publication of the details in so attractive a manner it is possible to create that spirit of enthusiasm without which the maximum benefit is impossible of realisation. Not only does this apply to the sales staff but to all re-sellers who are, or may be, intimately concerned with the proposition at issue. We commend the effort, which is well calculated to benefit the re-seller as well as the G.E.C.

Various Items.

Dalston Picture Theatre.—We are informed that this large Cinema, which is one of the finest in North London, is illuminated throughout by Osram lamps.

Tenders Accepted.—The L.C.C. have accepted the tender of the B.T.-H. Co., Ltd., at £15,056 for H.T. and L.T. switch gear for the Holborn and Streatham sub-stations, where B.T.-H. rotary converters are to be installed.

Meetings.—The next monthly meeting of the Birmingham and District Electric Club will be held at the Grand Hotel, Colmore Row, on Saturday, 12th inst., at 7 p.m. Paper: "Gyroscopic Compass," by Mr. H. F. Stevenson (vice-president).

Burnley.—The Albert Mills at Barrowford are to be electrically driven and lighted. The firm have decided to adopt the group system, the motors being mounted on brackets fixed to the wall and directly geared to the line shafts. The control apparatus will be grouped.

Drawing Instruments.—Readers who may at the present time have to purchase drawing instruments for use in the course of their office routine or class studies, should make a point of writing at once to Messrs. Stanley and Co., Ltd., at 286, High Holborn, W.C.1, and ask for a copy of their new catalogue L7. It is sure to prove of interest.

Mexico.—The report for 1920-21 on the economic and financial conditions, by Mr. Norman King, can be obtained from H.M. Stationery Office for 1s. The general tone of the report is "not so bad." We certainly have hopes for a successful future for this country.

Greenock.—The Corporation has agreed to set up machinery in the Glebe Sugar Refinery to generate electricity from the waste steam at these works. After supplying electricity to the refinery it is estimated that there will be from 700 to 900 kilowatts available for the Corporation.

Illuminating Engineering Society.—The opening meeting of the session will be held at the Royal Society of Arts (John Street, Adelphi), at 8 p.m. on Nov. 15, when reports on progress during the vacation and developments in lamps and lighting appliances will be presented and apparatus exhibited.

Inst. of Costs and Works Accountants.—The next preliminary, intermediate and final examinations will be held on Dec. 5, 6 and 7, at London, Manchester, Birmingham, Sheffield, Glasgow and Bristol. Other centres will be arranged should sufficient demand arise. Forms of application can be obtained from the Secretary, 38, Grosvenor Gardens, S.W.1.

St. Anne's.—Debenture holders in Blackpool and St. Anne's Tramways Co., whose undertaking has been acquired by St. Annes District Council, have received a final distribution of 7.44 per cent. on arrears of 40 per cent. of interest. The capital of £148,935 was repaid a year ago, when the Preference shareholders received 2s. and the Ordinary shareholders 1s. per share, the only return for over 20 years.

General Conditions of Contract.—The Model Form of General Conditions recommended by the I.E.E. for use in connection with contracts has recently been revised. Copies may be obtained from the Secretary of the Institution, Savoy Place, Victoria Embankment, W.C.2, or from the publishers, Messrs. E. and F. N. Spon, Ltd., 57, Haymarket, London, S.W.1. The price per copy is 2s. (post free 2s. 2d.).

"La France."—No doubt many of our readers are studying French. In fact a knowledge of the language is an asset which often at unexpected times stands one in good stead, and therefore no apology is needed in referring to a new weekly revue of the French Press, known as *La France* and published by Evans Bros., Ltd., of Montague House, Russell Square, W.C.1. *La France* contains various items of news and humour, etc., as well as illustrations, and is particularly suited towards enabling students of French to improve or maintain their knowledge, whilst parents whose children are studying French will no doubt be glad to know of a weekly paper which is suitable for their needs.

I.E.E.—On Thursday of last week Mr. Ll. B. Atkinson vacated the Presidential chair in favour of Mr. J. S. Highfield, who delivered to a crowded audience an address devoted to capital, profit, labour and goods. We hope that it will soon be printed in the *Journal*, so that members and others may be enabled to make careful study of the many valuable points dealt with. There is no doubt but that attention to the suggestions in it would result in the more harmonious working of the "industrial machine," with the consequent benefit to the industry and therefore to the country.—It was intimated at the meeting that, to meet the oft-expressed wish of members, it had been decided to keep the library open on two evenings a week until 9.30. As an experiment to determine which evenings are most suitable, from Nov. 14 to Christmas the library will be open till 9.30 on every evening and also on Saturday afternoons.

Serb-Croat-Slovene State.—The D.O.T. has recently issued a report on the Geological and Mineral Resources of the Serb-Croat-Slovene State. This publication, which may be obtained from H.M. Stationery Office, Kingsway, W.C.2, price 3s. 10d. post free, is the only work on the subject in the English language. It contains an extensive survey of the mineral wealth of the country, with detailed descriptions of the location of the various deposits, and notes on the state of workings and the progress of the mining industry generally throughout the kingdom. The sections dealing with the coal and iron ore resources are, in particular, of an exhaustive character, and furnish much useful data in regard to analyses, output, estimated reserves, etc. Attached to the report are three appendices containing a bibliography of principal mining publications on Yugoslavia, a glossary of the principal Serbian mining terms, and a copy of the mining laws of the country, while the value and interest of the report are also enhanced by the number of maps, plates and illustrations.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

NOVEMBER 18, 1921.

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LOW VOLTAGE OVERHEAD DISTRIBUTION *

By Burkewood Welbourn.

General.—The distribution of electrical energy by bare overhead conductors has not been so favourably considered in the United Kingdom as in Canada, the U.S.A., Italy, France, Spain, etc., and it was scarcely used in this country until after 1890, when it began to be fostered by Mr. Gerald Balfour, the then President of the Board of Trade, at the instigation of Mr. A. P. Trotter. Since then overhead distribution has made slow progress and has been wholly or partially used in a good many rural townships, etc., two of the oldest and most important schemes being those of Ebbw Vale and Ystradgynlais in South Wales.

It is neither possible nor desirable to cover all the points concerning an overhead system within the limits imposed on these notes, and the author proposes to deal chiefly with some important features which need discussion.

Standardisation.—The B.E.S.A. has recently issued a specification for creosoted wood poles, and has in hand the preparation of specifications for telegraph and telephone line materials. Much of the work is in an advanced state, and several of them should be ready for issue this year. The specifications which deal with insulators and pole fittings will be particularly useful for light power work, while the elaborate specification for different types of tubular light steel poles may be helpful in some directions. The B.E.S.A. also has in preparation specifications for copper and aluminium conductors and steel strand, but their completion is dependent on the results of extensive tests which are being made at the N.P.L. for the B.E.A.I.R.A.

Regulations.—Overhead lines are required to comply with "Regulations prescribed by the Board of Trade under Section IV. of the Electric Lighting Act, 1888." These Regulations are now administered by the Electricity Commissioners under the Ministry of Transport in accordance with the Electricity Supply Act, 1919, and it is understood that they are now under revision with the assistance of an *ad hoc* Committee appointed by the I.E.E. It should be noted that the existing regulations prescribe factors of safety as follows:—

Line wires	5 at least
Wooden poles	10 ,,
Iron or steel structures	6 ,,

taking the maximum possible wind pressure at 25 lbs. (altered from 30) per square foot, while no addition need then be made for a possible accumulation of snow. No temperature is mentioned, but it is presumed that 22° F. is intended.

These factors of safety are highly controversial—they are seldom observed, and it is generally hoped that they will be replaced by some more logical rules this year which will obtain ready acceptance.

For high voltage lines the Commissioners have announced their acceptance of new factors of safety:—

Line wires	2.0 at least,
Wooden poles	3.0 ,,
Steel structures	2.5 ,,

taking the wind pressure at 13½ lbs. per square foot with a radial ice loading on the conductors of 0.5 inch at a minimum temperature of 22° F., the wind pressure being calculated on 0.6 times the diameter of the ice-covered conductor, while allowance may be made for the elasticity of the conductor.

It would be difficult to apply these factors of safety to low voltage lines in *sheltered* situations, and speakers in the discussion might usefully express their views as to what is practicable.

Other points on which discussion would be helpful are:—

Voltage.—Whether, in the interests of standardisation of lamps, motors, etc., as well as of voltage regulation, it is possible to arrange for new work to be carried out at a declared voltage of, say, 240 volts to the neutral. Regard should be paid to the question of transforming down to some lower voltage at each house, and, if so, whether a higher voltage to the neutral than 240 is permissible on the street wires.

Conductors.—Whether these should be stranded only or whether solid wires are permissible under any circumstances having regard to the fact that the conductors may be of (*a*) copper, or (*b*) aluminium, or even of (*c*) steel or iron. Attention might also be paid to the use of weatherproof wires and their limitations.

Services.—Whether these should be of bare wire or of insulated cable.

Height of Wires.—Whether the present minimum of 22 feet from the ground might be reduced for certain classes of roads.

Poles.—Experiences with different types of poles:—(*a*) Creosoted wood; (*b*) tubular and lattice steel; (*c*) reinforced-concrete.

With this question is wrapped up the large question of the possibility of making use of houses to carry brackets for the supporting of conductors without danger to the public or to the residents or to workmen employed on the houses.

Protection of the Public.—Whether the present methods of guarding required by the Electricity Commissioners and the G.P.O. are sufficient or too onerous, and in what directions they might be simplified or made less costly.

Lightning Protection.—Whether anyone has discovered any entirely effectual way of preventing lightning getting on to the internal house-wiring.

Earthing.—For lines which give a supply to consumers at pressures above 250 volts, the regulations require that a continuous earth wire should be provided, that all metal work on each pole should be connected to it, and that it should be definitely "earthed" at every fifth pole. Nothing is said about earthing at pressures below 250 volts, and, owing to the doubt which exists on the point, it is hoped that the Electricity Commissioners will make an early pronouncement on the subject. The author is decidedly of opinion that the fittings on each pole should not be "earthed" by a single wire coiled into a flat spiral beneath the lower end of the pole. There are various objections to it, the chief one being that the surrounding ground may

* Abstract of Paper discussed at the Engineering Conference 1921 (Institute of Civil Engineers).

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not in all cases provide an efficient "earth." Discussion on this subject is very desirable.

Cost.—The question of distribution by overhead wires *versus* underground cables is a controversial one, and cases may sometimes be settled by first-cost considerations, but, fortunately, æsthetic and maintenance conditions are sometimes given their full value—especially in garden city schemes. In one such scheme the total first-cost of the overhead distribution, including 108 public lighting fittings, has been £6,800, whereas the estimate for a high-class scheme using cables throughout was only some 20 per cent. higher. Allowing for the longer life and lower maintenance charges on cables, it is very doubtful whether there was any real saving by using overhead wires in this case. Exact cost obtained from other schemes would be very useful.

Conclusion.—The author has always held the view that overhead distribution has a special field of its own in the development stage of the electric supply industry in the U.K.—particularly in rural areas and in works and colliery distribution. The standard of work and appearance, as well as of continuity of supply, are much higher here than in many other countries, and the author believes that ultimately the distribution in all our towns, garden cities, and large villages will be done by underground cables. The basis for this belief partly lies in the growing practice of the G.P.O. in replacing overhead wires by cables even in country villages.

COLLIERY SWITCHGEAR.

The various Home Office regulations regarding electricity in mines have led to the development of lines of switchgear specially suited for use in fiery mines. Apart from the question of these regulations, however, the extended use of large electrical plant in collieries has increased the demand for switchgear of a reliable and substantial character capable of giving the arduous service required.

In connection with this subject a pamphlet, No. X.2574, has recently been issued by the General Electric Company, Ltd., giving brief particulars of their air-break switchgear. Other G.E.C. manufactures for colliery service (and, indeed, for heavy industrial work of any sort) include draw-out ironclad switchgear of the oil-break pattern. It is of the class known as "Unit" type, and consequently affords a high degree of compactness and adaptability (Fig. 1). Each unit consists of an oil switch, supported on a sliding carriage which is suitably mounted on a cast pedestal, the busbar chambers forming an integral part of the pedestal. Connection is made from the oil switch to the busbars by means of plug contacts. When the oil switch is withdrawn a special cover fitted to the bottom of the busbar chamber can be raised so as to completely enclose the contact sockets. The oil switches are designed with liberal clearances, and all the usual trips can be fitted, and easily adjustable time lags added if required. Interlocking arrangements are

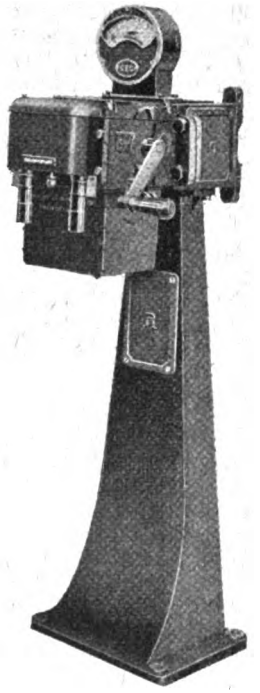


FIG. 2.—G.E.C. PEDESTAL MOUNTED OIL SWITCH.

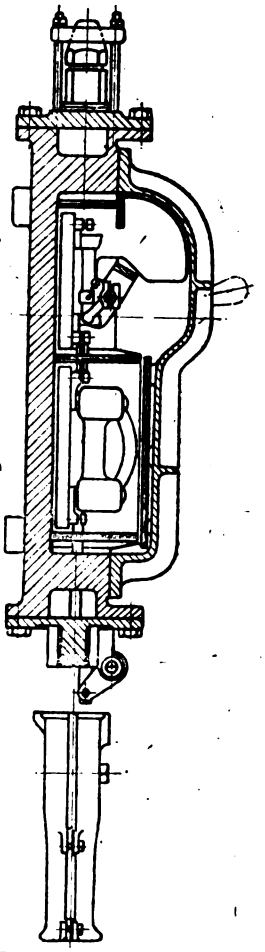


FIG. 3. — "SALFORD" FLAME-PROOF SWITCH AND FUSES WITH INTERLOCKED PLUG.

provided which render all parts dead before there is any chance of an operator making accidental contact. A special catch ensures that the body of the switch is not withdrawn too far unless it is wished to take the switch completely

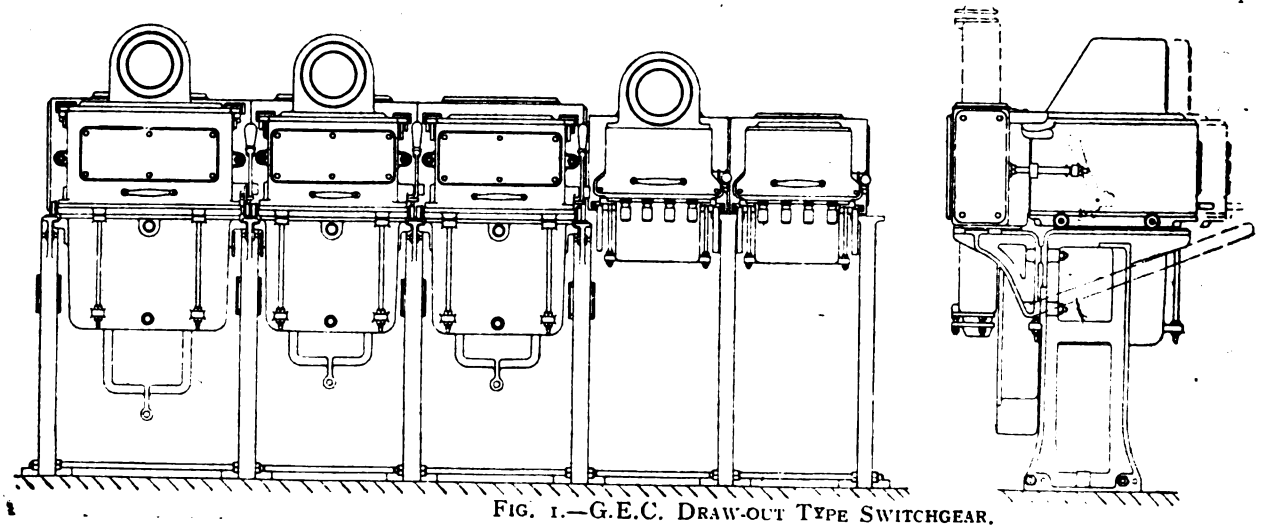


FIG. 1.—G.E.C. DRAW-OUT TYPE SWITCHGEAR.

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away from the pedestal. This gear can be supplied either as ordinary ironclad or flame-proof apparatus. Measuring instruments and cable boxes are generally included in the design.

Where gear of a more modest nature is required a very neat unit is provided by the pedestal mounted oil switch shown in Fig. 2. In this type the oil switch is bolted to the busbar chamber, which, in turn, is fixed to the top of the pedestal. The type of oil switch used for pedestal mounting is eminently suitable for iron framework or wall mounting.

Reverting to air-break switchgear, it may be said that the ensuing flame-proof designs are robust and are fitted with wide machined flanges on the case and door, so that heated gases generated within shall not be able to pass to the outside atmosphere until the temperature is reduced well within the safe limit. A good example is the 50 amp. "Gate End" box, consisting of a "Salford" switch, fuses and plug, which is made in both double and triple pole sizes. This is clearly seen in Fig. 3. An inspection of the "Salford" type switch reveals that the break is long and rapid, and the force necessary to operate the blade is transmitted by means of steel stampings which prevent any chance of straining in springs. The springs quicken the break only after the blade has left the jaws. The poles of the switch are separated by means of a substantial fire-proof insulating barrier which effectually prevents arcing from one pole to the other. The usual mechanical interlock is provided to safeguard the attendant. In each detail throughout there are evidences of a thoroughly first-class piece of apparatus. The fuses are the well-known "Handguard" type, in which the hand is very effectively shielded. The plugs are interlocked with the switch in such a manner that the switch must always be in the "off" position before the plug can be inserted or removed. This is of great importance as it prevents the circuits being made or broken on the plug. Earthing contacts are provided in accordance with the H.O. regulations. Special attention is given to the design of the glands and bifurcating and trifurcating boxes to ensure that the heated gases have no exit except through the wide machined flanges of the case.

Other items illustrated and described in the pamphlet cover several sizes of flame-proof switch, and switch and fuses, in sizes from 5 to 50 amps, suitable for lighting or power circuits, as well as cut-outs, and the well-known "Salford" circuit breakers enclosed in flame-proof cast iron cases for use in mines.

THE "LOUD SPEAKER" TELEPHONE SYSTEM.

"I can confirm my estimate that the President's noble speech on Armistice Day was heard by 250,000 people, and it might have been heard by millions, but for the fact that only a limited amount of equipment is available for the present, and the installations were confined to Washington, New York and San Francisco. To bring the matter home to your side of the Atlantic, one may emphasise that it should be relatively easy in the early future for Mr. Lloyd George, for example, to speak at the Mansion House and for his voice to be heard perfectly throughout the centres of the British Islands. In a chat yesterday with officials of the American Telegraph and Telephone Company, I was informed that by far the most difficult problems which had to be solved were those involving the transmission and reproduction of a speech with perfect fidelity so that all the individual characteristics and modulations of the speaker's voice, slight though these might be, would be accurately preserved. These problems, it is claimed, have now been successfully solved, and the present loud speaker system is eminently satisfactory, both as regards volume and articulation, and so marks a distinct advance in the art of transmitting the human voice.

"The system comprises essentially two distinct sets of equipment. For conveying the speech to distant places the most improved type of telephone circuit was employed. This circuit, a development made within the last two years by the American Telephone and Telegraph Company, is characterised by the very perfect quality of the transmission, so that after transmission and amplification voices sound entirely natural, being devoid of any suggestion of mechanical quality. The time of transit of the voice across country by this circuit was about one-fiftieth of a second. In New York, nearly 300 miles from Washington, the speech, coming from a cluster of projectors, could be understood easily 1,000 feet away."—*Daily Telegraph*, November 14, 1921.

TELEGRAPHY.—GRADE I. (1921).

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in April, 1921.

(*Continued from page* 585.)

*Q.*10.—Describe, with sketches, a Post Office differential galvanometer. Why is an induced needle used and of what material is the pointer made? Why does the pointer come to rest in a vertical position? How would you test the galvanometer to prove whether it was differential?

A.10.—Fig. 1. shows the internal construction of a Post Office differential galvanometer. The Spagnoletti needle *n s* is paddle-shaped and is made in two parts, the latter being separated magnetically from each other by a thin strip of spelter. The axle is also made in

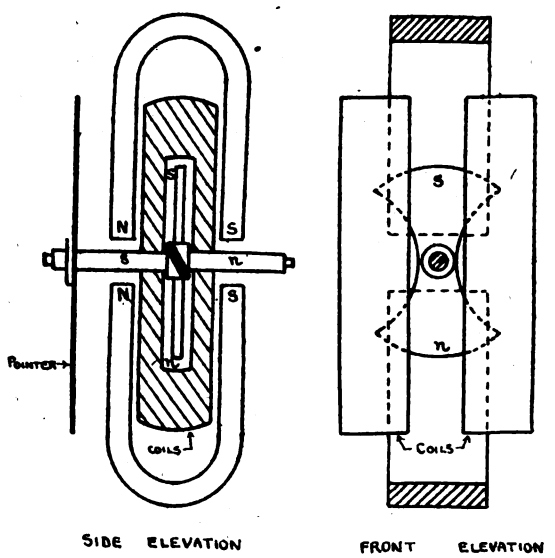


FIG. 1

two parts, the front part being an extension of the lower half of the needle, and the back part being an extension of the upper half of the needle. The needle is magnetised inductively by two horseshoe magnets, *NS*, *NS*, mounted one above the other with similar poles adjacent, as shown. The needle is enclosed almost entirely by two coils, which are placed side by side between the limbs of the permanent magnets. Each coil is wound with two wires of exactly the same length and joined up to four external terminals, so as to form

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two independent circuits. The passage of a current through either of these circuits causes the needle to reflect to the right or left according to the direction of the current, hence if equal but opposite currents be sent through the two circuits no deflection at all will take place. If the currents in the circuits are unequal, a deflection proportional to the excess of the stronger over the weaker current will be produced. The coils have each a resistance of 50 ohms, and each is shunted with a resistance of 300 ohms, the effect of the latter being to minimise the effect of the self-induction of the coils. The external terminals may be joined together and to a circuit in a number of ways, so that the coils may be in series or parallel, or connected up differentially as indicated in Fig. 2.

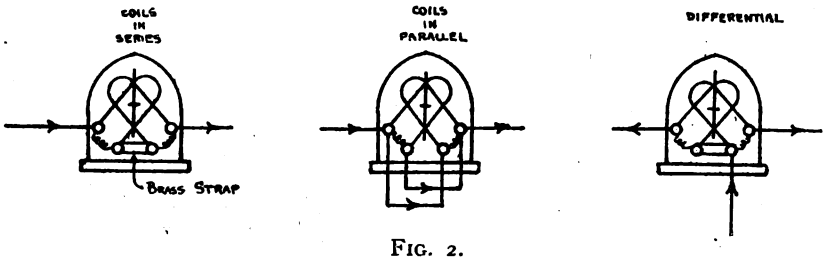


FIG. 2.

An induced needle is used instead of a permanently magnetised needle, because it is not liable to be demagnetised and reversed in polarity by working currents, or by lightning discharges. The axle of the needle carries at one end a non-magnetic pointer, usually of brass which has its visible surface blackened. This pointer moves over a graduated dial.

The pointer comes to rest in a vertical position, because of the perfectly balanced shape of the needle, and also to the fact that the induced magnetism of the bottom of the needle is of *N* polarity, the controlling force being solely the magnetic effect of the earth.

The galvanometer may be tested for differentiality by joining up a battery and key as shown in Fig. 3.

If the pointer of the galvanometer shows no deflection when the key is worked, the instrument is differential. A similar test should be made with the current passing through the coils in the opposite direction to that of the first test.

(*To be continued.*)

INDIRECT LIGHTING.

In order to overcome the objection to indirect lighting on account of the "dead" effect of the unilluminated surface of the bowl, a new and unique fitting, the Marco Bowl, has now been introduced by Z Electric Lamp and Supplies Co., Ltd., 73, Newman Street, W., in which this objectionable feature is overcome by a patent method of imparting the property of translucence to plaster castings. This method provides an economical and artistic form of lighting bowl, as any desired design, however elaborate, may be moulded instead of having to be turned and carved out of the solid material. As the casts are reinforced with fabric, thus ensuring great strength, any desired colour or marble effect may be obtained by suitably colouring or designing the fabric before it is embedded in the plaster cast. The general effect is that when not illuminated the bowl has the appearance of pure white marble or alabaster, but when illuminated it glows on its under surface with whatever colour scheme or design is imprinted on the reinforcing fabric, particularly novel and beautiful effects being obtained. The bowl also retains such a degree of opacity that no matter how brilliant the colouring may be in its effect, no coloured rays are thrown into the room being illuminated, and a pure white diffused light is obtained in every part. The system is capable of wide application and can be adapted for friezes, panelling, etc. The Z Coy. intimate that they are open to receive inquiries and to submit schemes and designs.

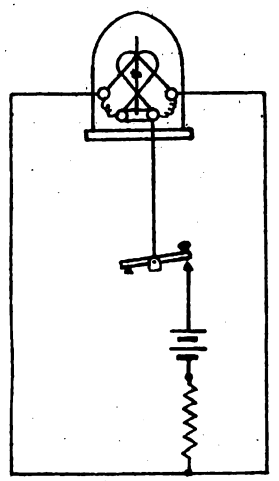


FIG. 3.

THE WATT MOTOR.

The Watt Motor, which is a squirrel-cage machine of special construction, develops 2 to 2½ times its normal torque at starting with a current of 3 to 3½ times the normal. It has been fully described in our columns, and a description can now be obtained from the manufacturers, Watt Motors, Ltd. (Premier House, 150, Southampton Row, W.C.)1, in the form of a handsome illustrated bulletin. The publication in question points out the distinctive features of the Watt Motor, and describes its construction and operation, giving several test results. Various illustrations of the motor and its component parts are given, together with views of the factory. Dimension drawings of protected and enclosed mining type motors for 2 and 3 phase, 25 to 60 cycles, are given, as well as approximate shipping specifications. The motors are made in standard sizes from about ¼ h.p. to 90 h.p. The chief points of note in the motor are in the stator and rotor windings, the connections of the former to the starter terminals being a modification of the star-delta system for 3-phase motors, and the series parallel system for 2-phase motors. In rotor (patented) several parallel conductors of different conductivities are arranged in each slot, whereby high starting torque, with low starting current, high power factor, high efficiency, and mechanical strength are combined.

N.E. Midlands Electricity District.—The local inquiry by the Commissioners into this proposed District will be held on November 29 in the Town Hall, Sheffield. The Sheffield Corporation scheme will be considered.

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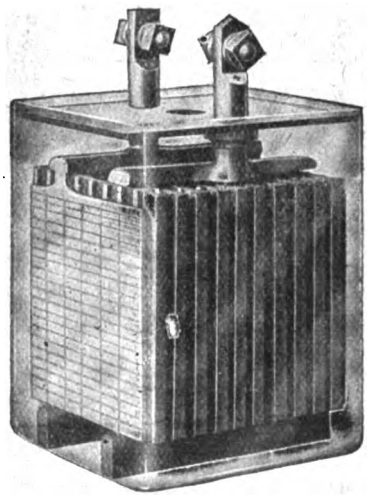


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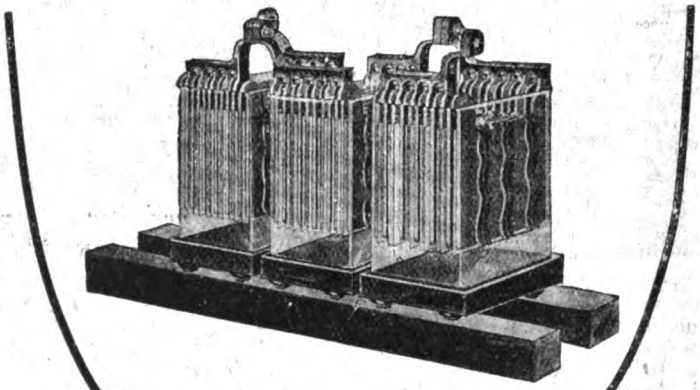
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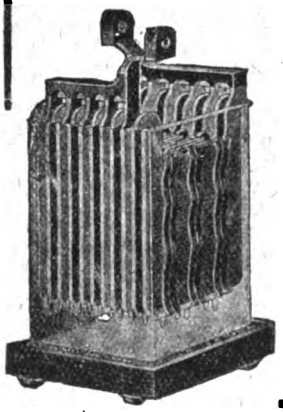
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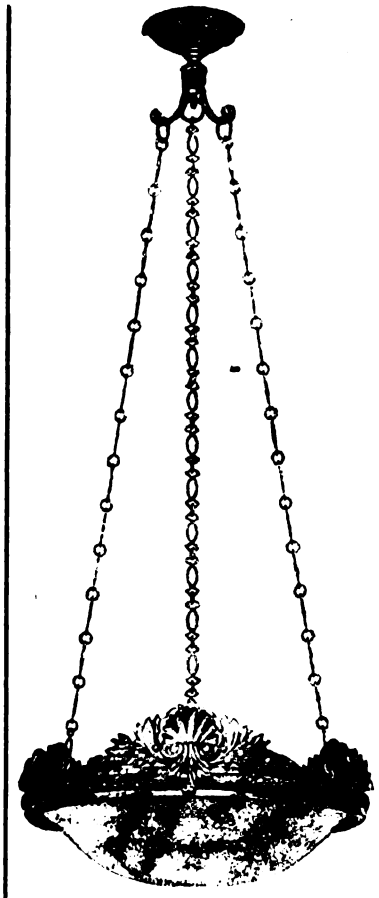


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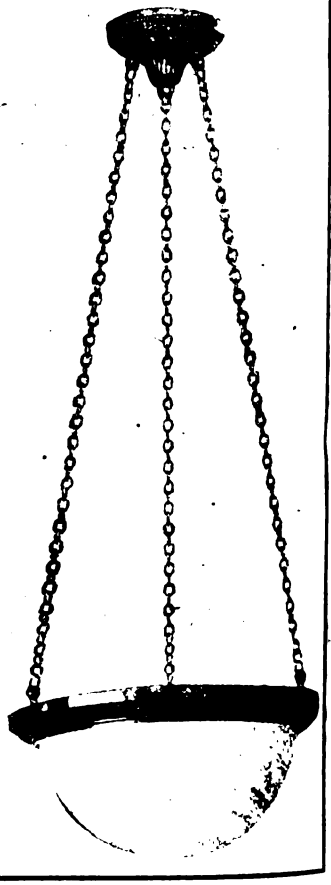
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

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Current Topics.

Wireless Progress.

Recent accomplishments in the world of wireless research and evolution go to show that by this marvellous modern means of communication distance is no longer an object, and the limitations of worldly space have at all events been overcome. President Harding's recent message from the new Rocky Point, Long Island, wireless station was received in London, Germany, Melbourne, and many other equally distant receiving stations. In effect it encircled the earth, and further achievements in the matter of distances bridged would appear calculated to revive the problem of what happened to the snake which started to swallow its own tail.

These wonderful results are not achieved by simple or inexpensive means, as will be gauged by the fact that the Rocky Point antennæ are mounted on a line of towers each 400 feet high, and covering a distance of three miles from end to end. Nor is wire telephony far behind in point of distance bridged, since a group of reporters in the Arlington National Cemetery, Washington, the burial place of America's war heroes, were able to listen to the "Last Post," played by a bugler standing on the roof of the civic auditorium at San Francisco, 3,000 miles away. A chime of bells followed the bugle call, and then a reading from the Scriptures, which, overheard by certain tourists who were unaware of the experiment, caused consternation among the more superstitious of the party.

Owing to the considerably augmented energy required to transmit voice currents by wireless, the limitations of distance have not yet been overcome, although the first commercial wireless telephone service between London and Holland is shortly to be established, provided official Post Office sanction is forthcoming. This service will be by land wire to Southwold, Suffolk, thence across the North Sea by wireless to Zandvoor, and onward by land wire to Rotterdam or Amsterdam. Conversation has already been successfully carried on between Marconi House and Holland by way of a preliminary test. The only regular wireless telephone service at present existing in this country is that between the Mersey Docks and Harbour Board offices and the Bar Lightship, situated about a dozen miles out in the Irish Channel off Liverpool. The service is used for reports concerning weather and shipping.

Corporation Trading Rights.

The recent action brought by a number of Liverpool electrical contractors against the Corporation to restrain the latter from carrying on contracting business on their own account, raises once again the old vexed question of municipal electrical trading in its bearing on the popularising of electricity for lighting and other domestic purposes, such as heating and cooking. One can quite understand and sympathise with the views of individual traders in a city, who are also ratepayers, in regard to competitive activities by the municipal department which supplies the current and thus makes their business possible. On the other hand, there is much to be said on behalf of the progressive municipality which has electrical energy to sell and the public to serve, realising at the same time that the electrical trading interests of the city are, perhaps, not doing all that they might to assist towards the common goal.

As I have previously remarked in my notes, there is far too little co-operation between the trade and the supply authority in most towns where electricity supply is concerned. The municipality leave it to the contractor to educate and induce the public to adopt electric light and other electrical possibilities in their homes, whilst the latter, for his part, keeps his eyes and ears open for any likely installation jobs, and, as a rule, is not sufficiently influential or able to make an effective display of electrical service on a large scale. Hence the Corporation showroom development, which, after all, does go some way towards the ideal we all aim at, but fails in its inability to sell direct to the consumer.

What is most needed is wholesale co-operation between the local electrical traders and the Corporation electricity supply departments in every town and city of the kingdom. Their interests are mutual, since the contractor and dealer derives his profit from the sale of lamps, fittings and appliances, and the wiring of premises, whilst the supply authority can only bring down its generating costs by increasing the demand and evening up the load line. There is plenty of advertising on the part of electrical manufacturers and the trade; there might be more with advantage, but the fault does not lie here. It is to be found in the absence of personal canvass of potential consumers in districts already served by supply mains.

I know personally dozens of householders, in as many different districts, who have lived in the same houses for years, have always been gas consumers, fully realise the advantages of electricity for lighting and heating through personal experience at their places of business, but have never once been approached by the local trade or the supply authority with a proposal to adopt this form of illuminant for their houses. Can it be wondered at, in the circumstances, that electrical service is still conspicuous by its absence in many of our most populous centres? If a canvasser is selling soap, or boot polish, books, sewing machines—in short, any of the hundred and one things utilised by the modern housewife—he goes from door to door in every street, bringing his wares

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to the notice of the tenant. Why do not the supply authority and the contractor get together on a similar stunt? It would be calculated to add many new consumers to the list, and make for the improvement of trade in electrical fittings and appliances.

In his address as chairman of the Liverpool Subcommittee of the Institution of Electrical Engineers at the University, Mr. G. H. Nisbett issued an opportune plea for greater enterprise in thus encouraging the use of electricity. He pointed out very truly that the power supply side of the electrical business had been boomed at the expense of electric lighting, inasmuch as manufacturers using electric power had been given very attractive wholesale terms for electricity in bulk, whilst ordinary consumers for lighting and other small services were not encouraged to increase their demand by attractive unit prices.

This is the more anomalous seeing that the cost per unit of electricity for power purposes in a large factory does not bear vitally on the final costs of manufactured products. It is not a paramount factor in the cost of a finished article produced by its aid, figuring in most cases at from 1 to 2½ per cent. of the total. There is thus scant justification for charging for electrical energy from the same source at the rate of 7d. or 8d. per unit for lighting, and 2d. per unit with rebates for power or heating and cooking. Among novel suggestions put forward by Mr. Nisbett were that the supply authority should undertake responsibility for wiring consumers' premises, quote him a price for the work, and place it with responsible and approved contractors. Alternatively, the authority should act as consultant, and issue a certificate on satisfactory completion of the job. In circumstances where the initial expense was a deterrent, it was suggested that the authority should itself pay for the wiring, making no initial charge to the consumer, but recouping itself by a slight additional charge per unit or a separate rental charge.

Good News.

I notice with pleasure that the men in at least one trade are beginning to realise that the high wages demanded through the Union leaders, combined with various absurd rules and regulations, are steadily driving more and more work into the hands of the foreigner. In this instance it is ship repairing, which is being diverted to Hamburg, Rotterdam, Antwerp, and even to Spain, because of our high prices. Therefore, to hear that on the Mersey, where there are over ten thousand unemployed from the shipyards, the men are actually beginning to know the cause and to relax the rules which prevent them from getting work and wages, is a healthy sign. Fancy a Trade Union fining its members for working overtime on a ship-repairing job on the North-east coast, when, if it had not been worked, the order would have gone abroad. It is tantamount to asking an employer not to employ English labour because the leaders would rather the men were unemployed than deviate from their rules. Talk about red tape. It is calculated to make any patriotic ex-Service-man see pink rats

ELEKTRON.

THE FINSBURY O.S.A. DINNER.

On Saturday last the members of the Finsbury Technical College Old Students' Association, to the number of 85, dined and wined together at The Engineers' Club, under the presidency of Professor G. T. Morgan, O.B.E., etc., who was supported by such well-known veterans as Messrs. Esson, Walmsley, Wallis-Jones, Tennant, Head, Raworth, Moss, Hale, Coats, Guy, etc., as well as a goodly muster of visitors like Prof. Donnan, Dr. Forster, Prof. Philpot, etc. After "The King," Prof. Donnan proposed "The College," in a speech full of humorous witticisms, which evoked frequent bursts of laughter. He stated frankly that ever since he had known the college he had regarded it with admiration as a fine place for imparting instruction in a way which might be likened to the principles of British liberty and freedom, because so much was taught based on actual practical experience. In other words, the professors made the students search for information in text-books and laboratories, which bore out the teachings imparted in the lectures. In his view, some of the modern methods in the universities were radically wrong, and Finsbury had proved the soundness of its system by turning out a very large number of men who were holding high positions in every part of the globe. (Cheers.) Further, he felt that the present century was one in which chemists, physicists and engineers would all be working together, and he rejoiced to hear that Finsbury was not going to reduce its output in that direction.

Prof. Eccles, in reply, referred to the charming secretaries, with whom he was humorously credited as being surrounded, and also to the mottoes on which he acted, and stated that a year ago, owing to the shocking taxation of the City and Guilds' income, the message from the college was S.O.S., R.S.V.P., while the answer to the riddle was reported to be a lemon. At any rate, Dr. Morgan might be called a resurrectionist. Last year his speech might have been termed a funeral oration, but this year a spirit of generosity seemed to have seized the local education authority. On the other hand, it meant filling up a formidable array of forms, but, joking apart, he could but express the gratitude of the college authorities to the L.C.C. and to all who had helped in the great cause.

In proposing the toast of the "Old Students' Association," Dr. Forster smilingly referred to the two previous speakers, and to the previous year's speeches, which had then dealt so much with the approaching decease of the college, which had been due so largely to the fact that the students had paid 4d. for an education which cost 9d. (Laughter.) In other words, for £40 per annum they received an education which costs £100 per annum. He then expatiated on the real generosity of the City and Guilds of London, who had started the college in 1878, and since that time had given more than one million pounds to it, a statement which was appreciated and applauded by all present. In conclusion, he wished continued strength and prosperity to the association.

To this toast Prof. Morgan gave an excellent reply, dealing with the efforts which had been made to speak up for the City and Guilds' Institute, after which he went on to refer to the work which had been done by the Defence Committee and which yet had to be done. He also referred to the work of Messrs. Guy and Clark in connection with the dinner and concert, and his vote of thanks to those gentlemen was enthusiastically supported by all present.

Finally, Mr. W. G. Head, the president-elect, proposed "The Guests," in a felicitous, but brief, speech, in which he brought in a neat reference to the balancing of engines and the balancing (on their return home) of the members who had been to the dinner, and quoted a good medical yarn in support of his case.

Prof. Philpot's reply was one of decided optimism in regard to the future of Finsbury. An excellent musical

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programme (arranged by Mr. Clark) was interspersed between the speeches, and "Auld Lang Syne," followed by "God Save the King," terminated a very successful evening. Old students who have not yet joined the association and wish to do so, should send in their names to Mr. H. P. Guy, 209, Northumberland Park, London, N.17. He will receive them with pleasure. Now then, buck up!

OLD 'UN.

THE GYROSCOPIC COMPASS.

On Saturday last a paper upon the above subject was read before the Birmingham and District Electric Club by Mr. H. F. Steventon (vice-president). The lecturer gave some account of the theory and principles of the gyroscope, and then described the early history of the application of those principles to the mariner's compass, pointing out that the construction of iron ships, together with the heavy steel armaments of modern warships, had made the magnetic compass exceedingly unreliable, and had rendered the necessary corrections a very complicated process.

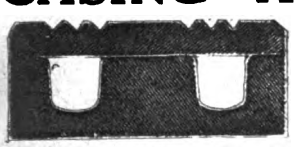
The introduction of the Gyroscopic Compass had provided a mechanical substitute with considerable torque. It was possible, therefore, by electrical impulse to control any number of subsidiary compasses in different parts of the ship. It also made possible the keeping of an automatic record of a ship's course, and went very far to eliminate the fallible human element.

The construction of the Sperry Gyroscopic Compass, with its highly ingenious design and wonderful workmanship was described, together with the specially designed electric motors used for motive power. Such a high degree of perfection had been reached that the manufacturers guaranteed that after the failure of the electric current, the compass would still give readings for three and a half hours within half a degree of accuracy, and the gyroscope itself would continue to revolve for over seven hours.

There were mathematical problems involved by the varying periphery speeds of the earth at different latitudes, and also by the varying speeds at which the ship itself travelled; but all these problems were purely mathematical, and could be dealt with by suitable formulæ with accuracy, whereas the vagaries of the magnetic compass on a modern iron ship did not lend themselves to the same accuracy.

As evidence of the growing appreciation of the greater reliability of the Gyro Compass, and in spite of its great expense, all modern ships of war were so equipped, and over fifty British merchantmen have been equipped during the past two years.

CASING AND CAPPING.



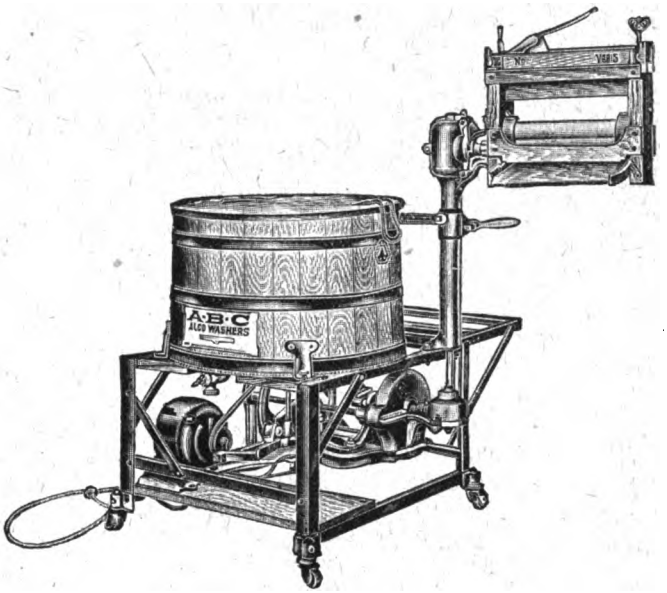
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THE "ALCO" ELECTRIC WASHER AND WRINGER.

The "Alco" electric washer and wringer is a machine operating on the dolly principle and is manufactured in the same factory as the "A.B.C." super-electric washer (Sun Electrical Co., Ltd., 118-120, Charing Cross Road, W.C.2). It is made in two sizes, with one tub or two tubs, and is provided with a full swinging wringer with quick safety release which can be locked in any position. A folding bench is also attached. At the present state of development of the washing machine, it is probable that the cylinder type as represented by the "A.B.C." super-electric



is the best for washing clothes electrically, yet in the "Alco" we have an efficient device which operates on a system which is known to large numbers of the British Public. The tub of the "Alco" is of 26 in. diameter at the bottom and 32 in. at the top, and is substantially constructed of Louisiana cypress. The general construction is well seen in the illustration, the motor is of ¼ h.p. With the twin tub "Alco," both tubs (capacity each, 6 full-size beds sheets) can wash simultaneously or separately to meet the needs of the operator. With both single and twin tub models the "A.B.C." Ironer, previously described, can be operated.

PREPARING AND MOUNTING MICA INSULATION IN COMMUTATORS.

Useful suggestions made by the Western Insulation Co. (Chicago) concerning the manipulation of mica insulation for commutators will doubtless interest our readers. A fine-toothed band saw with moderate set should be used to cut the segments, because any tearing of the edges increases the opportunity for forming short-circuits when turning up the commutator. The assembled bars and segments should be heated gradually to between 350 and 400 degrees F., and kept at this temperature for long enough to produce even heating throughout. The clamps should be tightened gradually as the commutator cools. The combined effect of the heating and tightening is to cause the micas to adhere very firmly to the bars.

The next step is to turn the Vees for the mica and rings. Any roughness produced on the surface of the turned grooves must be removed before the rings are put in place, and both the grooves and the rings should be dusted carefully just before they are brought together. If either of these precautions be neglected, the mica will subsequently be subject to risks of breakdown, either by leakage or puncture. With the rings in place the commutator should again be heated to about 300 degrees F. to embed the ends

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of the segments and set the cement in the rings. The clamping rings should be tightened gradually as the commutator cools, the final tightening being given when nearly cold. A final pressure of about 1,500 lbs. per sq. in. on the inside taper ring gives good results, and, particularly in the case of small commutators, care should be taken that the pressure on the clamp ring is not sufficient to distort it, causing its angle to change.

INTERNATIONAL CONFERENCE ON H.T. TRANSMISSION SYSTEMS.

The Union des Syndicats de l'Electricite, of which Mr. Tribot Laspierre is the Gen. Sec., have invited the following countries to send delegates to a conference, to be held in Paris (November 24th) to discuss the various technical problems relating to H.T. transmission systems:—Great Britain, Belgium, Spain, United States, France, Holland, Italy and Switzerland.

The following delegates have been nominated by the I.E.E. to represent the British interests:—Mr. P. V. Hunter, Mr. E. B. Wedmore, and W. B. Woodhouse.

A complete programme of the meeting will be supplied free of charge on application to the Secretary, International Electrotechnical Commission, 28, Victoria Street, S.W.1.

SUBMERSIBLE ELECTRIC MOTORS FOR MINE'S PUMPS.*

By A. J. Ramsay.

(*Continued from page* 627)

Sinking Pumps.

An example of a sinking pump, which the author recently designed throughout at the works of Messrs. Submersible Motors, Limited, will be cited as representing the latest practice in this type of machine. The machine is for mine-shaft sinking in China, and several novel features are incorporated in the design. The duty is as follows:—Pump, 1,000 gallons per minute at 600 ft. T.M.H.; motor, 280/300 h.p., 1,460 r.p.m., 380 volts, three-phase, and 50 periods. Figs. 7 to 10 show a sectional arrangement of this set and some of the details; it will be noticed that for mechanical reasons the pump and motor are separate units. The motor is of the standard squirrel-cage submersible type, constructed generally on the lines as described in detail earlier in the paper. The end windings are protected by a split cylindrical casing of metal in order to prevent damage to the windings when removing or assembling the rotor. This casing is tied to the motor frame by studs not shown on the drawing.

The three leads to the stator windings pass through separate stuffing boxes to the cable coupling, which is mounted direct to the top cover of the motor. This coupling is constructed in much the same manner as those previously described, but special provision is made for extra strength in the casing on account of the stresses likely to be put upon it when raising and lowering the set. It will be seen that the armouring of the three-core feeder is clamped and effectively earthed in the neck of the top half-coupling. After the connections are made, the whole of the interior is filled with insulating compound. The coupling is capable of carrying 500 amperes continuously.

The three radial bearings are of the rustless-steel roller type, and are contained in housings filled with grease as lubricant. A "Mitchell" thrust bearing of liberal rating is provided at the top, and is specially mounted in a housing surrounded with a water-jacket. The top cap of the housing is shrouded to project over and protect from damage the two oil-circulating pipes of the thrust bearing. The principle of the automatic lubricators attached to the three radial bearing housings will be understood by reference to the drawings. A cylindrical casing with a bottle-neck which connects to the housing interior is filled with grease lubricant, and a packed piston is placed on top of the lubricant. A cover seals the free end, and the pressure pipe connects the space on the top side of the piston with the interior of the motor body or pump. The pressure exerted at the nose of the bearing housing at any time and under all conditions is thus balanced by the piston exerting an equal pressure through the lubricant at the rear of the housing. By additional mass in the piston or by other means, an excess of pressure can be arranged for within the lubricator to ensure that the housing is continuously filled. It will be obvious that very prolonged running without attention can be provided for, which is of vital importance in sinking operations. A charging cylinder is fitted at the top of the set, from which point the lubricators when necessary can be filled with grease. This operation will easily be understood from the drawing. Each lubricator is connected by a pipe with the charging cylinder, and a turncock is provided in each connecting pipe immediately beneath the cylinder, thus giving independent control. The water for cooling the motor is taken from the back of the last stage impeller and passes through ducts around the stuffing box, thus providing effective cooling at this point. The water passes through a regulating valve into a double filter shown on the right hand side of Fig. 7. The first portion of the filter is similar in design to that already described in this paper, and is provided at the free end with a "dished" cover to receive sediment. A cover of the "Nunan and Stove" pattern is fitted at the botton of the "dish" to enable accumulations of sediment to be quickly blown out. Direct coupled to this filter is another of different design, the water in this case passing through cylinder walls of very fine wire gauze mounted on a stiff spider. It will be seen that it is possible to withdraw both filters for cleaning, without disturbing the pipe connections. Provision is made for duplicating the filters, if found necessary. Seeing that the water has to pass the impeller clearances before entering the filters, the size of particles of foreign matter is limited at the outset. A further control valve is fitted in the supply pipe at the entrance to the motor. The arrows show the direction of the water passing upwards and finally around the thrust bearing housing, thence by a pipe to the pump suction.

It was considered advisable on a set of this size to provide some safety arrangement in connection with the cooling water for the motor.

The pump may be submerged for long periods when examination is impossible, and the filter or passages connecting the same may become blocked and the motor thereby seriously damaged. An inlet valve is provided on the top of the motor shown in the set on Fig. 7. This valve is controlled by a spring, and is surrounded externally by a perforated casing, which acts as a filter. If for any reason the main filtering system fails to operate, then, owing to the reduction of pressure within the motor and the pressure of water on the exterior, the valve will open and admit water for cooling the motor. Further, if the pump be running on suction, this valve would admit air under the above conditions, which would pass to the pump suction, thereby reducing the output of pump and the load on the motor. The operator would have his attention drawn to the trouble by both the pump gauges and the electrical instruments.

The complete machine is mounted in a slinging frame with a wire rope pulley for double suspension. The delivery pipe passes up between the two ropes, and the whole weight of the pipe is distributed over the slinging frame. (*Concluded on page* 640)

*Abstract of paper read before the North Staffordshire Inst. of Mining Engineers and first published in *The Mining Electrical Engineer*.

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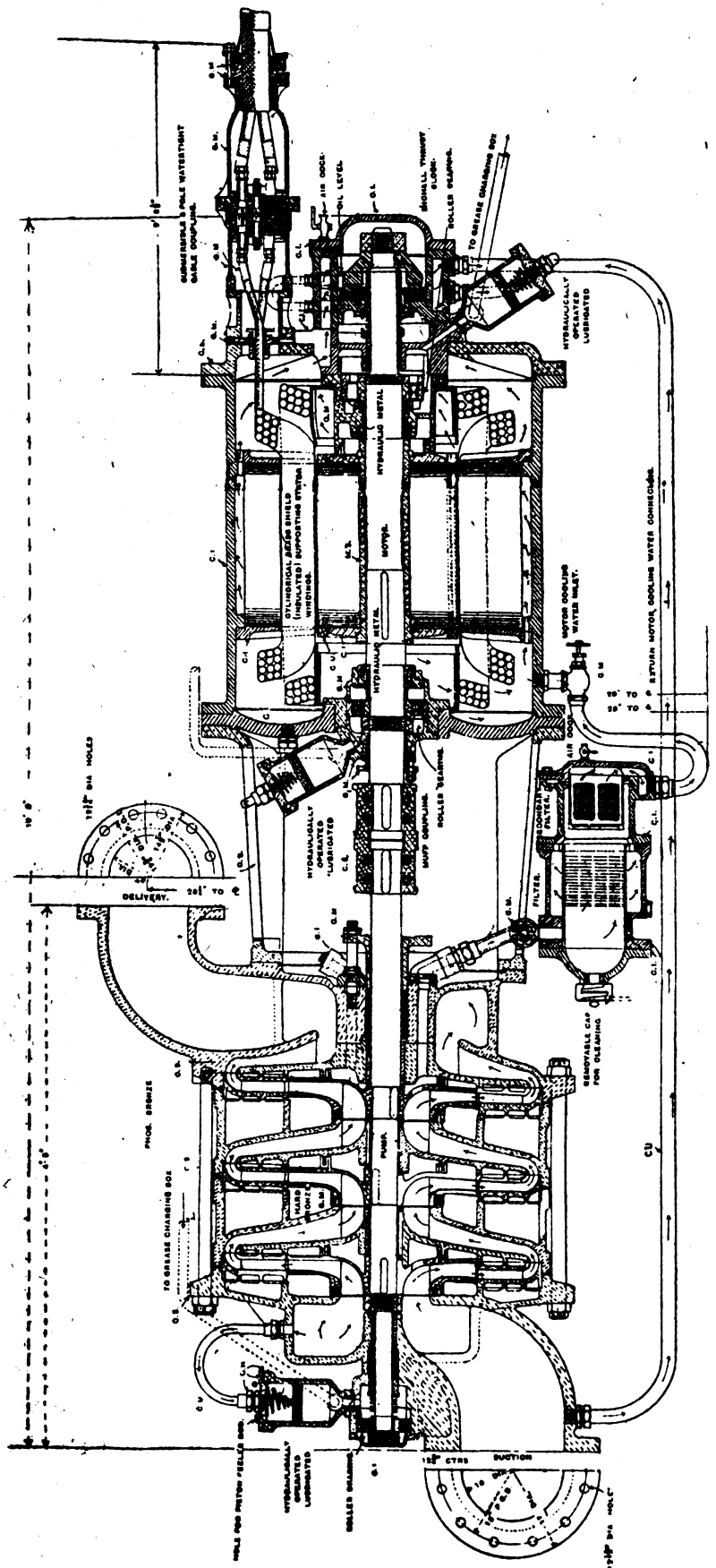


FIG. 7.—GENERAL ARRANGEMENT OF A TYPICAL HIGH-LIFT SUBMERSIBLE MOTOR PUMP, DESIGNED FOR SHAFT-SINKING SERVICE.

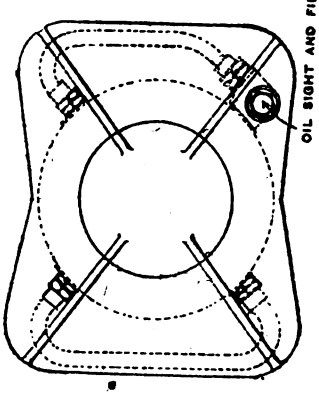


FIG. 10.—OIL-CIRCULATION PIPES, WITH PROTECTION CAP FOR THRUST BEARINGS.

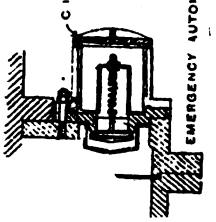


FIG. 9.—EMERGENCY AUTOMATIC VALVE

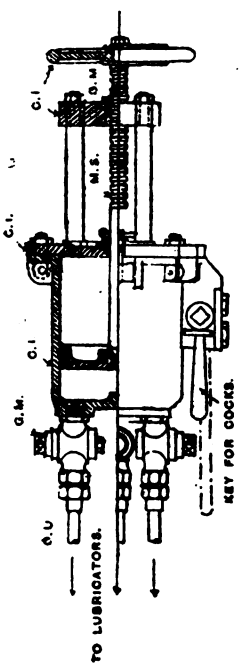


FIG. 8.—GREASE-BOX FOR CHARGING LUBRICATORS.

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MAIN PUMPING.

The submersible motor is certainly as desirable for main pumps as for the other duties already dealt with. With control gear mounted in a "safe" place, the motor pump is not in danger of being ruined when pits are suddenly shut down and labour withdrawn. In addition, there is no necessity for choosing "safe" positions for the pumping plant, and great flexibility is allowed the engineer in choice of position, and in placing the pump in that which gives the greatest utility.

In places where it is desirable to have control gear near to the motor pump for convenience in working, the author would suggest that dual control gear be fitted at some point always accessible under the worst conceivable conditions. The additional capital cost would be only a small insurance premium against the destruction of expensive plant.

Trade Notes.

Full details and prices of knife switches, manufactured by Sprecher and Schuh Coy., of Aarau, Switzerland, are given in List No. 1, issued by **J. B. Rudkin** (212a, Shaftesbury Avenue, W.C.2). Lists covering the Company's other manufactures are in preparation.

The Newcastle-on-Tyne branch of **Simplex Conduits, Ltd.,** formerly at 61-5, High Bridge, is now at 72, St. Mary's Place, under the management of Mr. A. G. Robson as hitherto. The telephone number and telegraphic address are unaltered, i.e., 2615 Central and "Simplex, Newcastle-on-Tyne," respectively.

We have received an excellently produced brochure, well calculated to impress the recipient with the large and varied engineering work in connection with all power plant for traction, lighting and industrial supply undertaken by the publishers, **Daniel Adamson and Co., Ltd.** (Engineering Works, Dukinfield, Manchester), in all parts of the world.

We have received our copy of the Monthly Magazine and Motor Stock List, issued by **Higgs Bros.** (Sand Pits, Birmingham), and hope that our readers interested commercially in motors and dynamos have received theirs. As usual the technical section contains matter of practical value, and the humorous pars. are sure to cause many a hearty laugh.

The Engineering and Lighting Equipment Co., Ltd. (Sphere Works, St. Albans, Herts), have issued a new leaflet dealing with their wide range of standardised and interchangeable brass ship, mill and dock fittings. The majority have been designed to take the "anti-break" disc—a device designed to reduce lamp breakage to a minimum.

Mr. Eric Potter, reg. patent agent and consulting engineer; of Lonsdale Chambers, 27, Chancery Lane, London (Nottingham Office, Temple Buildings, Albert Street; 'phone, 4798; 'grams, Patent, Nottingham), advises us that owing to rapid expansion of business the consulting and supervising engineering work will henceforth be conducted under the style of **E. Potter and Co.** The activities of the Company will be concentrated upon factory architecture, installation of plant, and maintenance, etc., as heretofore. More commodious offices will be opened in the Midlands. New Nottingham offices will shortly be situate at Commerce Chambers (Elite Theatre), Parliament Street.

Various Items.

Mid-Lancs. Electricity District.—The time for the submission to the Electricity Commissioners of objections or representations has been extended until March 31, 1922.

Tenders Accepted.—The L.C.C. have accepted the tender at £895 of Messrs. Holt and Willetts, Cradley Heath, for an electric lift at the Stamford Hill Stores Depot.

Removal.—The Edison Swan Electric Co., Ltd., inform us that their Belfast Depot has now been removed to more commodious premises at 41, Chichester Street, to which address all communications should be sent.

Industrial Revolution.—Mr. H. E. Blain, C.B.E., M.Inst.T, Assistant Director of the London Underground Railways, is to lecture on Wednesday evening next, the 23rd inst., at Caxton Hall, at 7.30 p.m., on "The Industrial Revolution in England." Mr. A. Bellamy, C.B.E., ex-President of the N.U.R., is to preside.

The Electro Harmonic.—There was a goodly attendance at the Ladies' Night Concert, on Friday last. Mr. Highfield, President of the Inst. E.E. was in the chair and everybody seemed to enjoy the programme although the temperature of the room was not all that could be desired. On Friday, December 16, there will be a smoker and we hope that all who attend will be able to report a steady improvement in business. It will help to cheer things up.

Exhibition.—The Newcastle-upon-Tyne Electric Supply Co., Ltd., as well as Messrs. Robson and Coleman, electrical contractors, Newcastle; Gray Bros., electrical contractors, Newcastle; Siemens Bros. and Co., Ltd., Caxton House, Westminster; Electrical Devices, Ltd., Newcastle-upon-Tyne; and The Northern Steel and Hardware Co., Ltd., Manchester, are making a display at the Housing and Home Life Economy Exhibition, St. George's Drill Hall, St. Mary's Place, Newcastle-upon-Tyne, November 18 to December 3.

Hull.—At the invitation of Mr. A. E. Smith, District Superintendent of the Edison Swan Electric Co., Ltd., a party of 72, consisting of the leading electrical engineers of the district and their men, assembled at the Company's showrooms on Monday evening, November 14th, to hear and discuss a lecture on the Ediswan Wiring System by Mr. F. C. Raphael. Many practical points were raised in the discussion, which was wound up by Mr. Herbert Bell, O.B.E., the City Electrical Engineer, who expressed the opinion that some form of surface wiring system was essential in many cases to reduce the cost of electrical installations, and that the one described was the most suitable for the purpose he had seen.

Meetings.—On Tuesday, 22nd inst., the Institute of Industrial Administration will meet at 7.30 p.m. Subject:—"Unemployment Insurance for Individual Firms," by H. Lesser, Esq.——The Junior Inst. of Engineers will meet on Friday, 18th inst., at 7 p.m., Annual General Meeting. Also on Friday, 25th inst., at 8 p.m., "Electro-Magnetic Instruments—Problems in Design and Construction," by G. F. Shotter (Member). Exhibits and Demonstrations. And on Friday, December 2, at 8 p.m., Lecturette:—"Notes on Maintenance of Electrical Accumulators," by B. L. Ladkin. All at Caxton Hall. On Saturday, November 26, at 2.30 p.m., there will be a visit to the Locomotive Sheds of the G.W. Ry. at Old Oak Common.——The Inst. of Production Engineers will meet on Friday, the 25th inst., at the Inst. of Mech. Engineers, Storey's Gate, S.W., at 7.30 p.m., when Mr. A. F. Guyler will deliver a paper dealing with "Drawings and Production," to be illustrated by lantern slides.——The next regular meeting of the Kelvin Lodge will be held at Mark Masons' Hall, on Friday, November 25, at 4 p.m. Morning dress.





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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
NOVEMBER 25, 1921.

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ELECTRICITY SUPPLY DEVELOPMENTS IN THE UNITED KINGDOM.

The First Annual Report of the Electricity Commissioners commences with a review of the legislation which has governed the development of electricity supply in this country since the first Electric Lighting Act of 1882. The powers and duties of the Commissioners are then discussed and particulars are given of the work which they have accomplished towards the reorganisation of electricity supply. In the following paragraphs it is proposed to reproduce some of the more interesting information given in the Report concerning the general trend of development.

Early Legislation and its Cramping Effects.—The basic legislation of 1882 governing the establishment and operation of electricity undertakings was framed at a date when the generation and distribution of electrical energy on a commercial scale was in the experimental stage and when the main, if not the only objective was electric lighting. Undertakers at that date were expressly forbidden to associate themselves with any other company or person supplying electrical energy; advances in technical practice with regard to generation and distribution soon rendered much of the early plant obsolete; and the Board of Trade was not empowered to co-ordinate development from the purely technical standpoint.

The development of the electric motor and the practical application of three phase energy brought into prominence the possibilities attaching to large scale generation at high voltage, distribution over wide areas, and the general utilisation of electrical energy in industry. With a view to facilitating these developments, the famous Power Acts of the period 1900 to 1905 were introduced but—except in a few cases—they failed to bring about comprehensive systems of supply, because the undertakers under these Acts were forbidden to supply energy in the area of any existing authorised distributor except with the consent of the latter. Though the other powers conferred by these Acts marked a great advance in policy, they were of little avail so long as the towns and other industrial areas were virtually excluded from the ambit of the operations of the power companies.

In the circumstances and in view of the competition of the gas industry, it is not surprising that the development of electricity supply in this country has been less rapid than in other countries where development started later, and with the benefit of experience gained elsewhere. The largest pre-war output from the 500 or so supply stations in the United Kingdom was about 2,000 million units per annum—compared with 1,475 million units output in Sweden in 1914 (mainly from water power). This comparison is the more striking when it is remembered that the population of Sweden is about 5,500,000 (32 per square mile) compared with out own population of 45,400,000 or 374 per square mile. During the war, however, there was an extraordinary development in electricity supply in this country, chiefly in connection with the manufacture of munitions, and the output of our public supply stations more than doubled in four years, the figure for 1918 being 4,628 million units.

Multiplicity of Stations means Inefficiency.—It need hardly be pointed out that the inevitable results of the lack of co-ordination brought about by the original electrical legislation were unnecessary expenditure of capital, wasteful consumption of coal, and higher charges for electricity than would otherwise have been required. In Greater London alone there are 70 generating stations representing 50 different systems of supply, 24 voltages, and 10 different frequencies! Owing, in many cases, to the small size and high costs of public supply stations, manufacturers have found it cheaper to lay down private generating plant—thus extending the system of wasteful generation on a small scale in a multiplicity of stations. Not only does the existence of many systems of supply with different pressures and frequencies now offer a serious obstacle to the evolution of widespread interlinked networks, but also, for years past, the manufacture of the many different types of plant and apparatus has deprived British firms of the advantages which would have accrued—both at home and abroad—from concentration on the production of a few standard types.

Reorganisation Problems.—From the foregoing it will easily be appreciated how necessary was the Electricity (Supply) Act, 1919, what are the chief problems of reorganisation now before the electricity supply industry, and how difficult this essential reorganisation will be. It is not a question of starting *ab initio* to develop a comprehensive and standardised system of generation, transmission and distribution on the basis of present-day knowledge and practice, but rather of determining the best method of adapting, modifying and expanding the existing heterogeneous development so as to secure a speedy improvement in the supply of electricity for the many and growing needs of the community.

The prevailing economic conditions and high level of all costs make it impossible to carry out the work of reorganisation otherwise than gradually and by stages. In addition, however, to costly engineering work, the reorganisation involves a multiplicity of interests and it is essential to secure the co-operation and agreement of all those concerned in a particular district. The total difficulties to be overcome are thus so great that improvement in existing conditions is likely to occupy a much longer time than was estimated by optimists when the problem was under consideration prior to the passage of the Electricity Act of 1919.

Forcing the Pace?—The Act of 1919 lays down a definite procedure—involving a number of stages—in order to ensure full consideration of all schemes and proposals for the reorganisation of supply and for the safeguarding of all the interests involved. In a general way, such safeguards are entirely to be desired, but the whole history of the electrical industry shows that protracted legal procedure forms the opportunity of the obstructionists. Personally, we fear that the procedure laid down by the 1919 Act will be abused in many instances by those who wish, for one reason or another, to oppose the broad schemes of electricity supply which would make for the greatest good of the greatest number. Certain sacrifices must be made to attain this desirable end, but the Act provides for adequate compensation to be paid in respect of all material sacrifices so that—again expressing our own opinion—we should like to see the Commissioners endowed with more drastic powers of enforcing rapid reorganisation. It must be remembered

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that the Electricity Commissioners are not "officials" in the ordinary sense of the word—they are men of the highest standing in the electrical profession and are undoubtedly qualified to prepare schemes which will at least represent *within a very small margin* the best possible development of electricity supply in any particular district. Such schemes could be prepared quickly—why should they not be enforced, subject to nothing more than a short business-like discussion such as those which are conducted at meetings of the Institution of Electrical Engineers? As matters stand, it seems to us that there is opportunity for interminable legal proceedings concerning points *which are entirely of minor importance compared with the enormous savings which would at once be effected by the "Commissioners' scheme."* What justification can there be for continuing to penalise industry in general by permitting, say, 50 per cent. of waste to exist, simply in order to examine whether some other scheme would yield one or two per cent. higher efficiency or save twopennyworth of pride for someone?

Naturally, these points do not, and could not, form any part of the Commissioners' Report, but it is obvious that they are points which affect directly the possible speed of reorganisation of electricity supply. We have therefore expressed forcibly our own opinion on the subject and we invite correspondence from our readers.

The Trend of Reorganisation.—Soon after their appointment, the Commissioners made a preliminary survey of the present and prospective electrical requirements of a large part of the country and, on the basis of this survey, they determined provisionally thirteen Electricity Districts, the boundaries of which are shown on a map included in the Report. There cannot be the slightest doubt that great benefits will accrue to domestic and industrial consumers of electricity once Joint Electricity Authorities are formed in these and other districts and the resultant administrative, engineering and financial economies come into effect. Capital and coal will be saved and higher efficiency will be obtained from joint action.

The consent of the Commissioners must be obtained before laying down a new or extending an existing generating station or main transmission line, and when laying down a new private statio the owner is required to comply with any regulations made by the Commissioners concerning the type of current, frequency and pressure to be employed. By these powers, which are subject to reasonable safeguards, the Commissioners are able to ensure that any new works or extensions shall fit in ultimately with a co-ordinated engineering scheme for the improvement of electricity supply in any district. The policy of the Commissioners in this matter has been to avoid hindering development during the period which must elapse before any comprehensive schemes for reorganisation come into effect; to avoid extending badly-placed stations when a neighbouring better-placed station could be extended so as to render the desired service, and to avoid establishing or extending small stations where the balance of advantage is in favour of taking bulk supply from an alternative source.

Loan Periods.—Borrowing by Local Authority Undertakers is now subject to the consent of the Electricity Commissioners who have established a new and simplified schedule of repayment periods ranging from 60 years in respect of freehold land to 10 years in respect of meters, wiring of premises and some apparatus to be let on hire. If there is reason to expect that generating machinery and accessories are specially liable to be superseded by bulk supply or otherwise, the maximum period for loan repayment is 15 years.

Mutual Help and Fringe Supply.—Pending the establishment of a Joint Electricity Authority for a district, any two or more authorised authorities therein may obtain powers for mutual assistance in respect to giving and taking a supply of electricity and the distribution of electricity so taken. Such mutual assistance is, of course, on the lines contemplated by the whole scheme of reorganisation, and it is gratifying to note that a number of important undertakings are already working together in this manner. Another important step in the direction of general and efficient utilisation of electricity supply is the granting of Fringe Orders, under which supply authorities are empowered to supply consumers outside the normal area of their distribution. In the past it has not been uncommon for a private or industrial would-be consumer to be forbidden connection to mains which were already within a few yards of his premises, but situated in another supply area.

Systems of Supply.—One of the most important duties laid upon the Commissioners in the way of technical measures to bring about better conditions of electricity supply is the unification of type of current and frequency and voltage of supply. Of these, the most important consideration is probably the standardisation of frequency because large systems operating at different frequencies cannot easily be operated in parallel. After careful consideration, the Commissioners have come to the conclusion that a policy which would bring about one standard frequency throughout the country must be deferred for the present. They have, however, made it their policy to eliminate all odd frequencies so as gradually to reduce the number of frequencies in use to three, namely 50 (standard), 40 and 25 cycles per second.

All authorised undertakers are now required to render a return to the Commissioners every four weeks showing fuel consumed, units generated, and so forth. Naturally, the information so collected will be a useful guide to the conditions prevailing and the improvements effected. Taken in conjunction with the general statutory powers of the Commissioners and their authority to undertake experimental work and trials, there is now provided machinery which should do all that is humanly possible to improve the electricity supply industry—and with it the rest of the electrical industry, and so the prospects of every electrical worker, provided that all parties concerned work together to put into effect the policy as a whole. The cost of the reorganisation itself will necessarily be heavy, but the economies and other advantages obtained will represent an excellent return upon the outlay involved. The raising of the money in the first place may offer difficulties—especially under prevailing economic conditions—and in this connection it is probable that increased financial powers will have to be given to the Commissioners before they can make the constructive advances of which their position and general powers and qualifications render them capable. Concrete achievements are, of course, the real end in view, and it will be a calamity if, for political or other reasons, the powers of the Commissioners are so restricted in money matters as to stultify their efforts in other directions.

"MARCO" INDIRECT LIGHTING.

Last week, under the title "Indirect Lighting," we referred to the new "Marco" bowls which are made by the "Marco" Bowl Co., for whom the "Z" Electric Lamp and Supplies Co., Ltd., or 73, Newman Street, W.1, are the London agents. We have since inspected these bowls at the "Z" Company's showrooms, and find that the bowls, besides being very strong and light, have a very fine effect when illuminated. As coloured fabrics of almost any nature can be introduced into the fibrous bowls, it is at once apparent that they have, besides their artistic value, a wide advertising value. Besides bowls, the construction can be applied to illuminated friezes and panelling for all purposes, and we should not be surprised to find that they become very widely used.

While at the "Z" Company's showrooms, we saw a variety of heating and cooking devices, and among other items the hardy little Electrolux Suction Cleaner for domestic use as well as a larger model for larger houses, kinemas, theatres, banks, etc.

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A NEW AUTOMATIC REVERSING CONTROLLER.

The automatic reversing controller (Fig. 1) manufactured by the G.E.C. at the Witton Switchgear Works is rated at 25 amps, and is suitable for a 6 h.p. D.C. motor driving machine tool. By the adoption of a drum type of change-over switch for reversing the motor and by other points in the design, the number of moving parts has been made very small, and several of the new features are, we understand, protected by patents. Reference to Figs. 1 and 2 will show the construction, while the method of connection is seen in Fig. 3. Should the reversal of the motor be comes on again, it is necessary to move the controller handle to the "off" position before the motor can be re-started. This effectually protects against the danger of the machine re-starting when the voltage comes on again, should the handle be left in the running position.

Turning now to the construction of the contactor, the moving contactor is attached to the armature by means of a flat phosphor bronze spring, and is pressed with a combined rolling and rubbing motion against the fixed contact. By this means there is just sufficient friction to keep the contact surfaces in good order, and the method not only causes the contacts to meet and part at their tips, but

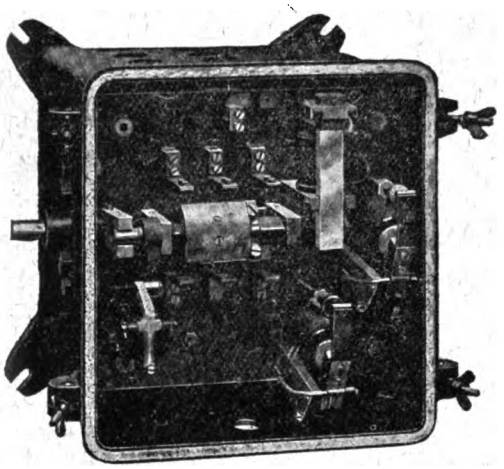


FIG. 1.—6 H.P. REVERSING CONTROLLER WITH COVER REMOVED.

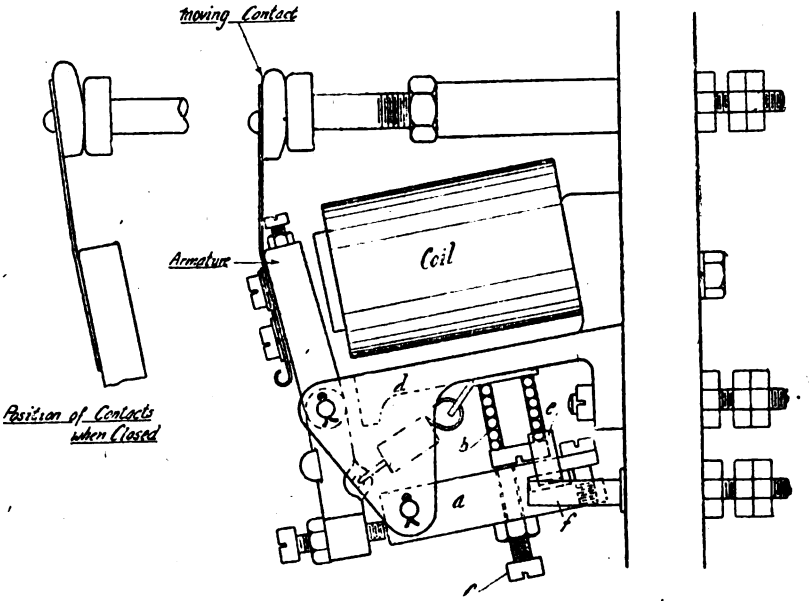


FIG. 2.—SIDE ELEVATION OF 25 AMP. CONTROLLER.

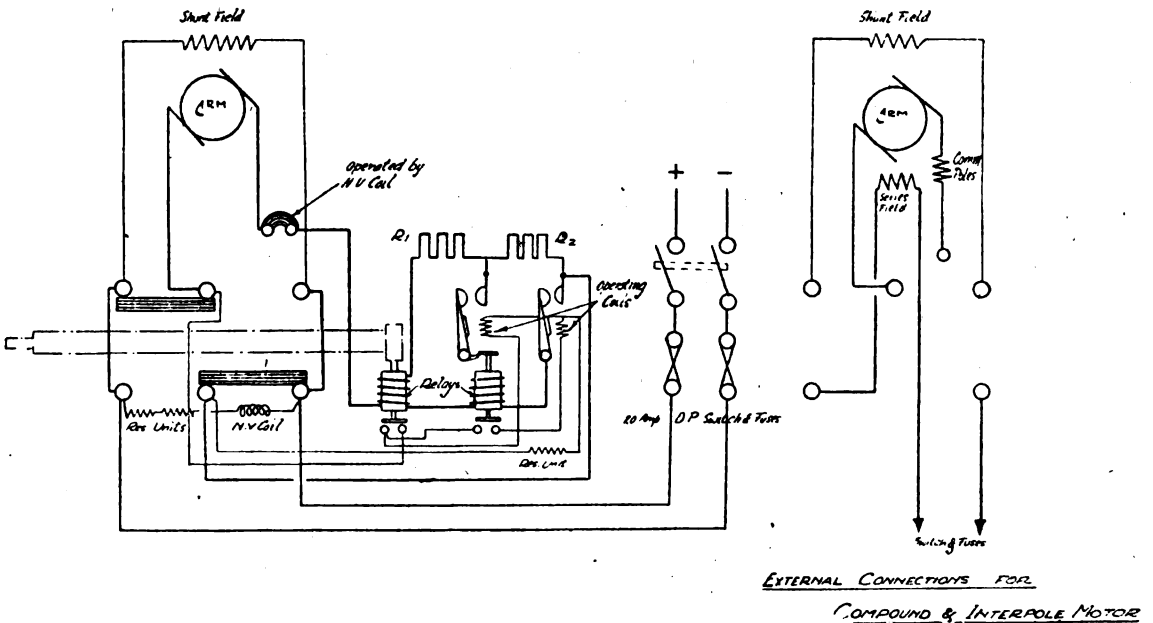


FIG. 3.—DIAGRAM OF CONNECTIONS OF CONTROLLER.

carried out by contactors, four units suitably interlocked and a double throw master switch would be required.

The no-volt safety device, shown about the middle of the upper half of the controller panel, consists of a break in the main armature circuit, which is bridged by a laminated contact when either the normal voltage is applied to the apparatus, or when the controller handle is in the "off" position. If the voltage goes off the shop mains, and then also to carry the current at the lower portion of their contact faces, where there is no chance of their being pitted or beaded by arcing.

Automatic current limit acceleration is secured by a novel design of relay. One of these is supported below the first contact or by brackets (*d*, Fig. 2) that are solid with the main castings. The air gap between the relay armature *a* and the pole piece *b* is adjustable by a brass distance

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screw *c*, so that the armature can drop when the current peak has fallen to a desired safe value. The falling of this armature closes the circuit for the next contactor by causing the moving contact *e* to bridge the two fixed posts *f*. In this way a step of the starting resistance is short circuited. This action is progressive, another such relay being interlocked with the reversing drum. Thus the resistance is cut out in two steps when the starting and secondary peaks have fallen to safe values. Further steps can be introduced, if desired, into such an automatic controller by merely employing one or more additional accelerating contactors, complete with their attached relays. However, two steps are ample for the purpose in hand.

The whole apparatus has been so designed as to fit into an ordinary starter box, with the necessary resistance behind the slate panel. This box contains not only the usual controlling resistance, but also a discharge resistance for the field (if this be shunt wound), and resistance units in series with the small armature coils. Although the main

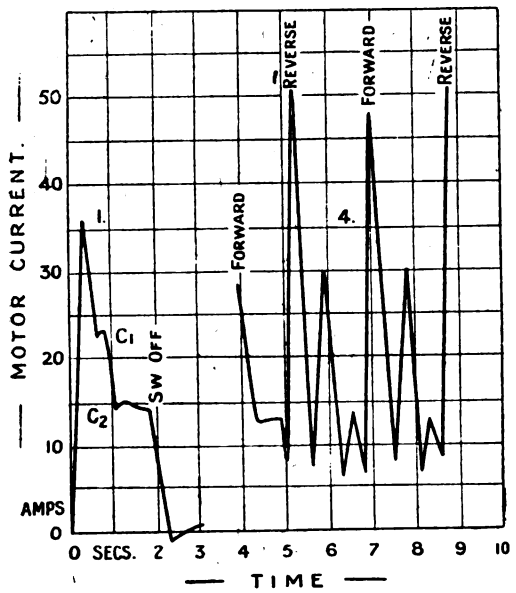


FIG. 4.—CURVES SHOWING CURRENT VARIATION UPON RAPID REVERSAL.

resistors are designed for starting duty only, they have been made robust and are capable of withstanding a continuous series of starts and reversals without overheating. The controller is intended to be used in conjunction with a G.E.C. standard ironclad switch and fuse boxes.

In Fig. 4 two curves, traced by a recording ammeter, show the rise and fall of the current when the controller is in operation, and demonstrate that the controller can withstand rough handling. The first curve illustrates the effect of simply switching on and then off again. The steady load on the motor is given by the final current, 14 amps., and this was derived from a rope brake. The normal full load current was 22 amps., and it will be seen that the highest peak, experienced when switching on, was only 60 per cent. above this. For the second curve, the controller was repeatedly reversed, without any pause on the "off" position. In order to make conditions severe, the motor was allowed to reach its maximum speed and then reversed, with the results shown. Even now the reversing peak is only given as 50 amps., or 123 per cent. above normal, while the intermediate peaks are far below this value.

It may also be mentioned, in conclusion, that one of these controllers was recently fitted to a 6 h.p. radial drill in an engineering workshop of a firm of well-known machine tool makers and tested by an operator moving the operating handle backwards and forwards as rapidly as possible. This, of course, connected the apparatus to the full voltage for forward and reverse running, and, in spite of this, we are advised, no part of the equipment suffered damage.

E.D.A. CHRISTMAS LITERATURE.

Among the folders and pamphlets, etc., prepared by the Electrical Development Association for the Christmas season we note especially one which makes an excellent "Xmas Card" for retailers of electric heating and other labour-saving appliances. It is executed in red and black, and is headed "Thys." Fourteen verses, with appropriate illustrations in each case, are all that appear on it, but there is a large space left for the retailer's name and address, etc. We give three verses:—

Thys is ye radiator bright,
That asks nor match nor tinder;
Ye little switch sets it alight,
And leaves nor soot nor cinder:

Thys is ye cleaner—hear it buzz!
It saves ye gude wife's muscles;
It gathers dirt and dust and fuzz,
As round the room it hustles:

Thys is ye smalle, convenient jugge,
Whereby ye swain and father
May smear hys rough and hairie mug-ge
With hot and soapie lather.

Another illustrated leaflet explains in doggerel verse how Mrs. Peter Ezekiel Brown decided to adopt electric heating, cooking, etc., and how she benefited.

Space limitations prevent our referring to the other excellent publications, particulars of which should be obtained at once from the E.D.A., at Hampden House, 84, Kingsway, W.C.2.

Correspondence.

RE THE E.P.E.A.

To the Editor of ELECTRICITY.

DEAR SIR,—The attention of my Committee has been drawn to the statements in the technical Press as to what happened at the meeting of the National Joint Board in respect to an agreement between the Electrical Power Engineers' Association and the Electrical Trades Union. The facts of the case are these: An agreement was entered into between my organisation and the E.P.E.A., provided that agreement could be reached on lines of demarcation of membership. Agreement has not been reached on the said point, and, therefore, there is no agreement between the two bodies. I have asked our General Secretary, Mr. Rowan, to confirm this statement.

Yours faithfully,
W. J. WEBB,
London District Secretary.

Visits.—Saturday, 26th inst., at 2.30 p.m., the Junr. Inst.E. will visit the Locomotive Sheds of the G.W.Rly. at Old Oak Common, and on Saturday, December 3, at 2.30 p.m., they will visit the Duroglass Works at Blackhorse Lane, Walthamstow.

Meetings.—The next Ordinary Meeting of the Inst.E.E. will be held in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C.2, on Thursday, December 1, at 6 p.m. Paper: "The Cyc Arc Process of Automatic Electric Welding," by L. J. Steele and H. Martin.——The Junior Inst. of Engineers will meet on Friday, 25th inst., at 8 p.m. Lecturette: "Electro-Magnetic Instruments—Problems in Design and Construction," by G. F. Shotter (Member). Exhibits and Demonstrations. Also on Friday, December 2, at 8 p.m., Lecturette: "Notes on Maintenance of Electrical Accumulators," by B. L. Ladkin. Both at Caxton Hall.

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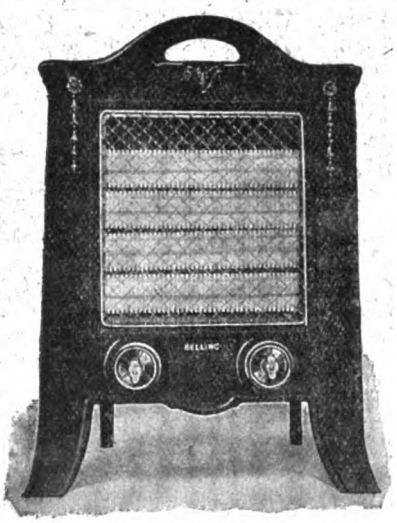
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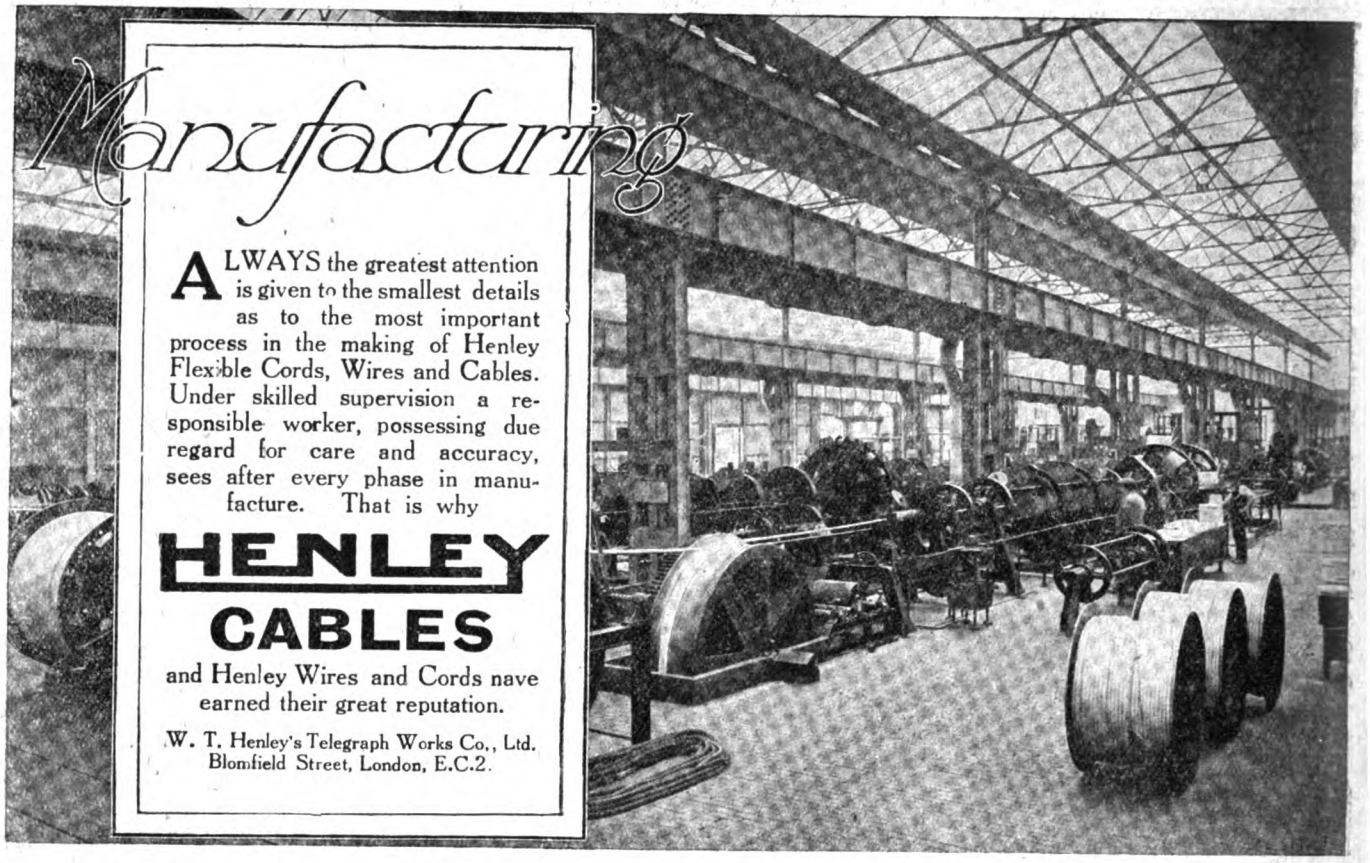
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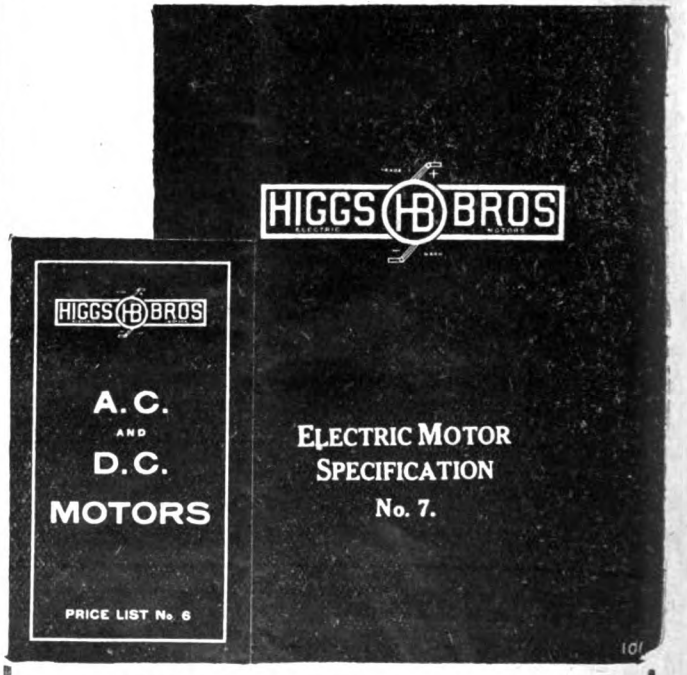
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TO OUR READERS.

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The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Cheap Coal.

The stumbling block in the way of cheaper coal at the point of consumption appears to be the transport question, and, so far as coal consumption for power generation is concerned, adds enormously to the importance of establishing new generating plants as near the pithead as is practicable. Latest f.o.b. costs per ton of South Wales coal are given by Mr. Finlay Gibson, secretary of the South Wales Coalowners' Association, as 26s. 3d. per ton, made up as follows: Pithead cost, 13s. per ton; other costs, 8s.; railway and dock charges, 5s. 3d. It will thus be seen that the cost of a ton of coal delivered free on board ship is practically double the figure at which it is brought to the surface. In other words, if the coal were consumed on the spot, it would cost only half the price which has to be paid when it is transported to a distance prior to consumption.

What a strong argument in support of pithead generating plant! It certainly would necessitate some additional outlay to transmit the generated electrical energy over similar distances to the point of consumption, but certainly nothing like 13s. per ton of coal burnt under modern boiler plant and ultra-efficient generating units. The fact of the matter is that British coal of the best grades is becoming too unwieldy to handle. It is more costly to win to-day than formerly, owing to the best seams having been worked to such depths that the money expended in winning it and bringing it to the surface is more than equivalent to what had to be expended a decade since in delivering it to the consumers' bunkers. If industries which depend upon cheap coal are to revive, we must make a drastic cut somewhere, and on the figures above stated considerable economies could be effected by removing the point of consumption from a distance to pithead locations.

We have not yet arrived at a practicable solution of a famous scientist's prophecy of underground steam-raising plant, where coal would be consumed actually *in situ*, where it has been placed by Nature, but the idea has possibilities which may be realised in the future. Meanwhile the next best thing is to adopt a compromise, and transport our mineral wealth as short a distance as possible—viz., to the surface of the earth at the point immediately above its natural location, and there make the best practical use of it as fuel for power, traction, and lighting. In the light of modern engineering development it has long been anomalous that steam locomotives should have to haul a considerable percentage of deadweight coal in their own tenders to furnish the power which keeps them moving, whilst the national expenditure on coal transport would astonish most readers as representing money which could be practically all saved by pithead consumption.

A Strike Echo.

It will be recalled by regular readers that I commented at the time on the ill-considered action of certain employees of the Hackney Borough Council Electricity Department in refusing to connect up the premises of a certain consumer whose wiring had been installed by non-union labour. As a result, the potential consumer brought an action against the Borough Council for non-fulfilment of contract, and won his case. On appeal, the decision has been confirmed, and a nice bill of costs will result, seeing that three judges and other legal luminaries had to sit to decide the issue. The case aptly illustrates the manner in which public money is wilfully wasted by these pettifogging squabbles over details which really do not matter a d——n.

Think of the complications, waste of time, expenditure of ratepayers' money, to say nothing of the ridiculous figure we cut in the eyes of other nations, when one or two trade unionists, controverting the principles of individual freedom on which our constitution is based, refuse to carry out legitimate and commonplace instructions because certain work had been performed by an individual who was not a fellow member of their industrial order. A peevish act in the first place, setting in motion ponderous legal machinery to decide the strictly legal aspect of the situation, and the man in the street looks on—and pays. Small wonder that Labour interests suffered such severe defeat at the recent municipal elections. In the light of this and similar happenings, the question "Is Labour fit to govern?" should find a ready answer.

The Civils.

We of the modern engineering era have been wont to regard the Institution of Civil Engineers as a very "pukka" institution; the *ultima thule* of co-operative engineering talent, in fact. And in point of age and historical archives no doubt it is. Founded in 1818, over a century ago, it took its name from the then concept of all engineering, other than purely military engineering, and was no doubt representative of the civilian engineering industry at that time. Latterly the "civil" engineer has been popularly associated with bridge design and building, the conception and erection of dams for the impounding of water, dock construction, and, in short, any important scheme of a general engineering nature. It is due, no doubt, to the imposing character of the schemes attributed to the genius of civil engineers that the associated institution has retained its popular title to consideration as the premier association of its kind.

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With the passage of time the Civils have adopted a somewhat exclusive policy, quite out of proportion to their professional qualifications. Engineering as a profession nowadays is necessarily sub-divided under a number of headings, according to the particular branch pursued by the skilled engineer; hence the existence of the kindred institutions—electrical, mechanical, chemical, etc.—each representing a more exactly defined branch of the general profession of engineering. In the result, the original institution, despite its age and historical archives, is in danger of losing its identity, and can ill afford to adopt an autocratic attitude towards its younger contemporaries.

In the circumstances, the presidential address of Mr. W. B. Worthington to the Institution of Civil Engineers is highly commendable as shedding new light on the subject and awakening the older members to a sense of the risks they incur by maintaining an attitude of icy isolation towards the remainder of their professional brethren. London is the home of tradition, and this fact doubtless contributes to the Civil exclusiveness. Engineers must march with the times, however, and we have a parallel in the old Society of Telegraph Engineers, which, when it had duly served its purpose, lost its original identity and became merged into the present flourishing Institution of Electrical Engineers. A far more vigorous growth this than one which still clings to the traditions of an engineering era long since passed away.

Payment by Results.

It is indeed refreshing to see that a sound and staunch trade unionist like Mr. W. A. Appleton has had the courage to admit in a book he has just written that he has come "to the conclusion that there can be no definite advancement in material well-being unless the value of the work performed is ascertained, and all workers paid according to the value of their labours." If the rank and file will admit that argument and work in accordance with it, then indeed, I think, we can look forward to the future with far more optimism. No sensible employer wishes to impose conditions akin to slavery. It is a most short-sighted policy. On the other hand, the hard and fast trade union rule that all workers in the same craft are supposed to be equally skilled is an absurdity. Some men are bound to be more expert than others, and therefore really able to earn more money by greater or better output. Why, then, should they be debarred from earning more, and thereby adding to the wealth of the country? The net result would be cheaper production with a bigger export trade, leading directly to cheaper food and cheaper living.

The laws of nature are inexorable. The clever and strong will push to the front. If all trade unionists are level and equal, why is one man selected as secretary? Because they think he is *better* fitted for the work. They don't choose a man likely to do it badly. But logically they ought to, because they maintain that all have equal ability and *must* be paid the same rate of wages. The same argument applies to the election of members of Parliament, and in many cases Labour members have made wise use of their intelligence and opportunities, with the result that they can grasp more clearly the difficulties with which employers have to contend. After which the Communistic crowd call them traitors to the cause, etc., and they retire gracefully into some fat Government billet.

ELEKTRON.

ELECTRICITY SUPPLY IN BETHNAL GREEN.

The recent opening of a new substation in Bethnal Green recalls that as long ago as 1899 a Provisional Order was obtained by the Council, but although sundry tentative efforts were made to carry the Order into effect, nothing was actually done until 1913, when Sir John Snell was asked to report to the Council on the matter.

He recommended that endeavours should be made to obtain supply in bulk from one of the adjacent local authorities, and that such supply should be taken to substations situated in the western and eastern portions of the borough, and that, when the demand warranted it, a third substation should be erected in the northern portion of the borough. Tenders were invited for a supply in bulk, and the offer of the neighbouring borough of Stepney was finally accepted, and a supplemental agreement was also entered into under which the Stepney B.C. managed the undertaking for a term of years.

In 1914 Sir John Snell resigned his appointment, and Mr. Harold W. Couzens, of 9, Old Queen Street, Westminster, was appointed Consulting Engineer to the Council, and has carried into effect the recommendations laid down in the original report.

The supply was started in 1916, but owing to the restrictions that were in existence during the war very little was done until after the armistice.

Since then, the undertaking has increased by leaps and bounds, and at the end of Dec. last there were the equivalent of 124,935 lamps of 30 watts each connected to the mains, of which, roughly, three-quarters is represented by motor-load. The requirements of the northern portion of the area increased to such a material extent that during last year it became necessary to consider the installation of a substation in the northern portion of the borough. Owing to the congested nature of the area, it was a difficult matter to find a suitable site, especially having regard to the fact that it was impossible to take over house property for this purpose owing to the lack of housing accommodation. Eventually, however, a site was found just off the Hackney Road, near Cambridge Heath Station, which consisted of a disused Wesleyan Chapel, and this chapel has now been converted into the new northern substation. The plant consists of 1-500 k.v.a. transformer, supplied by the Hackbridge Electric Construction Company, and 1-250 k.v.a. transformer, manufactured by the Metropolitan-Vickers Electrical Company. There is ample accommodation for further transformers, when required. The whole of the switchgear was supplied by the Metropolitan-Vickers Electrical Company, the E.H.T. gear being of their well-known cubicle construction, with the control apparatus on a platform erected above the cubicles. The E.H.T. board consists at present of five panels, there being a transformer and feeder panel on either end of the board and another panel in the middle, by means of which either half of the board can be rendered dead at any time for the purpose of overhaul. The L.T. board consists of six panels of white Sicilian marble, two being for the control of transformers and the remaining four for the control of .5 sq. in. 4-core feeder cables, which radiate from the substation. The mains for the network have been laid by the British Insulated and Helsby Cables, Ltd., and there is a .15 sq. in. E.H.T. feeder coming in from the eastern substation, and a similar feeder from the western substation, thus forming a ring-main so that a supply can be obtained from either end of the district.

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The energy is taken from the Stepney B.C. at a pressure of 6,200 volts, and is transformed down to a pressure of 415 volts for power purposes and 240 volts for lighting purposes

The system is, therefore, thoroughly up-to-date and will fit in with the main scheme for the supply of the Greater London District, whatever that may be.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 130.

Recently, I had cause to test two new 200 volt, 6 h.p., direct current motors. These are shunt machines, two poles, but the windings round the poles are connected in parallel. The rated speed is 1,400 r.p.m. On test the speed is 1,420 r.p.m. at full load, and 1,300 r.p.m. at no load. If, at no load, the rocker is moved to bring the speed up to 1,400 r.p.m., when the load is placed on the machine the machines race away as though the field was broken. Can any reader tell me why this should be, and what the remedy is?.—"TESTER."

(*Replies to Question No. 130 must be received not later than December 10, 1921.*)

Answers to Questions.

QUESTION NO. 125.

The second prize (5s.) *is awarded to "B.L.Y." for the following reply:—*

This question does not definitely state whether the calculations are required for the purpose of designing a new machine, or for rewinding purposes, but as certain factors are known it is assumed for the latter, otherwise various important details would have to be calculated, such as length, diameter of core, shape and number of slots, etc., before the stator turns could be found.

Since the speed and frequency are known, the number of poles should first be determined. This can be found by the formula $\frac{P=120\sim}{N}$, where $\sim$ is the frequency, and N the synchronous speed. The stator winding must be so designed that, neglecting the small ohmic drop, it will set up a counter E.M.F. equal to the applied EM.F. Then in the following formula, letting E_v = volts applied per phase, T = turns per phase, F = flux per pole, and $\sim$ = frequency, we obtain

$$E_v = \frac{4{\cdot}2\,F.T\rho}{10^8} \text{ for a 3-phase motor.}$$

or $$E_v = \frac{4\,F.T.d}{10^8} \text{ for a 2-phase motor.}$$

The approximate area of the air-gap must now be obtained, treating the stator as if with closed slots, and deducting about one-fourth of that area for slot openings. The value of flux, F, can then be found by multiplying the air-gap area by magnetic density. This density will vary from 20,000 to 27,000 lines per square inch for ordinary motors, and may be as high as 35,000 for traction and lift motors.

Assuming the copper losses in stator to be 4 per cent. the voltage per phase (E_v) = ·04 × E_v. With these values found, and substituted in above formula, the turns per phase will be

$$\frac{E_v \times 10^8}{4{\cdot}2 \times F \times \sim} \quad \text{or} \quad \frac{E_v \times 10^8}{4 \times F \times \sim}$$

The number of conductors per phase required will depend upon the starting torque required with a stated starting current. Thus if twice full load torque is required with full load current, the number of conductors will be double that to give full load torque with the same current. The slots per phase per pole is usually a number divisible both by 2 and 3, so that the same stampings may be used for both two and three-phase motors. To determine the size of conductor necessary the current per phase must be calculated thus:—

$$C = \frac{746H}{E_v.\, m.n.\, \rho f}$$

when H = Horse-power, E_v, voltage per phase, m = number of phases, n = efficiency, ρf = power factor.

The conductor should be selected to give a suitable current density, depending upon the speed and design of motor. For a small high-speed motor this will be about 2,500 amps. per square inch, whilst with a large, slow-speed motor it might be as low as 1,500 amps. per square inch.

B.L.Y.

MOTOR EXHIBITION.

At the Motor Exhibition (Olympia and White City) which closed on Saturday, the 12th inst., it was noted that the engines had cylinders varying in number from 2 to 12, some air cooled, some water cooled, and an example in which the lubricating oil is employed to get rid of unwanted heat. In most cases engines are vertical, but there are a few set V fashion. Monobloc casting is very popular, yet at least one firm groups four cylinders in both pairs and en bloc. Detachable cylinder heads are general and overhead valves are in increasing favour. Seldom are there more than the customary pair of valves to a cylinder, but one firm is utilising four. Pump and natural cooling systems are still contesting for supremacy. Magneto ignition shows no sign of being displaced. An occasional car relies upon a dynamo, but the rest utilise the magneto. Electric starters and lighting systems are even more popular than before, only certain low-powered cars having to be started by hand; mechanical "kick" starters are also noticeable. Aluminium is utilised a good deal for panelling, also for bonnets and fascia boards and for a goodly proportion of pistons. Silent chain drive is becoming popular for magneto and pump, and considerable thought has been given towards making the lubrication of the chassis a simpler and cleaner job. Conflict exists between the number of forward speeds. Numerous cars, usually of the lower powers, utilise four speeds, yet a large proportion are fitted with three. Gear boxes are durable and occasionally lubricated by the engine oil, the change of speed is effected either by a lever situated centrally or on the driver's right. In the latter case it is usually placed within the body.

Besides the interesting section devoted to motor boats, which also are being continually improved, the accessory

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side was very well represented, such firms as Benjamin Electric, Ltd., Fullers United Electric Works, Ltd., Conner Magneto and Ignition, Ltd., Chloride Electrical Storage Co., Ltd., Pirelli, Ltd. (tyres), and many other firms well known in the electrical industry having stands at which we believe they did excellent business.

THE G.E.C. SHOWROOM SERVICE.

We have on a previous occasion referred to the new premises of the General Electric Co., Ltd., at Magnet House, Kingsway, and have described at some length the fine suite of showrooms in which a most complete and representative display of electric light fittings and domestic electrical appliances are exhibited. A particularly interesting feature of these showrooms is that, owing to the varied styles in which the different salons are decorated, and the many colour schemes employed, the fittings can be examined in the most appropriate surroundings. Similar showrooms are arranged at each of the Coy.'s branches, and specially trained attendants are available to help clients in the choice of fixtures. Books of showroom introduction cards are supplied to the Trade, post free on request, and applications for these are invited.

In order that their clients may have an opportunity of acquainting themselves with the facilities afforded by the G.E.C. showroom service, an invitation is being mailed to the Trade. In case any names have been unavoidably overlooked, the Coy. hope that all their friends will pay an early visit to Magnet House, where they will be cordially welcomed and conducted through the showrooms and other interesting portions of the premises.

We are also informed that, consequent upon reductions in the cost of labour and material, the prices of the G.E.C. fittings and accessories have been revised. Two leaflets, giving the new list prices, are now being circularised and additional copies are obtainable upon application.

THE APPLICATION OF ELECTRICITY TO FARMING.

In a valuable paper recently read before the Royal Dutch Institution of Engineers at Nijmegen (Netherlands), Mr. R. Borlase Matthews contended that an extended use of electricity in farming operations was only a matter of the expiration of a comparatively brief time. Sufficient experimental and practical scale work had now been carried out in Denmark, Germany, Switzerland, Belgium, France, Italy and Great Britain, to demonstrate fully the necessity for the employment of electricity in modern agriculture if the farms were to be really profitable concerns. It was pointed out that the arguments that are to-day brought against the use of electricity on farms were practically identical with those advanced 15 to 25 years ago against its application to any other industry. Like the railways of Great Britain and other countries, farms lacked greater mechanical assistance owing to the existence of a superabundance of cheap labour. Since the war, however, the day of the cheap labourer has passed, and hence the necessity for electro-mechanical aids. As an illustration the author's farm of 600 acres at East Grinstead, Sussex, with such assistance, only requires three horses and no oxen. Similarly, any other farm could reduce its working animals and men if properly equipped with electrical appliances. Further, the electrical equipment of a farm ensures that the various operations are more independent of the weather, since they can be carried out more quickly when the weather suits; or in many cases they can be completed in spite of adverse weather (e.g., artificial electro-haymaking, corn sheaf drying, etc.).

The uses of electricity on farms can be divided into three main heads—(*a*) power uses in the farm buildings and barns, (*b*) power uses on the fields and arable land, and (*c*) uses which are specifically and peculiarly electrical, such as electro-culture. Illustrations were given of typical applications of electric drives, emphasis being laid on the fact that ultimately the ideal machine for the farmer was one that incorporated its own direct-coupled electric motor as opposed to operation by means of a line shaft—with its attendant difficulties of fixing in the usual farm buildings, which are generally far from strongly-built structures.

Various forms of portable electric motors were then discussed, particularly interesting among which were larger types of about 30 h.p., and the very substantial three-point suspension waggons employed for their support and conveyance. Electric light was referred to as advantageous to the farmer, not merely as a convenient and safe light, but also as a means of producing more eggs in winter and bringing on young stock to earlier maturity by more winter feeding and in artificial light. Examples were cited of the electric motor driving of machinery for the food preparation for live stock, dairy machinery and general barn machinery, including pumps, etc. Similarly, cases were given of applications on the land for irrigation, ploughing, cultivation and other field operations. Particular attention was drawn to the present-day development of electric ploughing, whereby, in skilled hands, 27 acres can be ploughed per day as compared with the bare acre per day of a man and team of horses. It was pointed out that on the "round-about" system, electric ploughing apparatus was now available for small fields at a cost for power that was comparable to the big electric ploughing sets, which, in turn, are far cheaper to operate than steam sets. The after-treatment of gathered crops was, of course, dealt with, as it is an important aspect of modern farming, as were likewise certain rural industries which can be conveniently operated in conjunction with a farm.

Considerable interest was evidenced in the author's account of the present development of electro-culture, which he stated had now arrived at the point where an increase of ten per cent. in the crop could be confidently expected, at a nominal current consumption and a low outlay for wiring per acre (excepting the initial capital cost of the transforming apparatus for which he had not yet been able to ascertain the simplest and cheapest design). The employment of electric vehicles on farms was then touched upon, and also the author's semi-automatic system of keeping farm (or, in fact, any other) accounts by the aid of an electrically operated machine—the author's contention being that detailed costings were the only true basis upon which it could be proved as to whether electro-farming was or was not a paying proposition; and any method which could produce these accounts without unnecessary expenditure of skill and time should certainly be worthy of adoption.

The meeting concluded with a special vote of thanks to the author, the President stating that more than the usual thanks were due by them to him, as he had come from another country to address them on a subject concerning which he has much valuable experience of a novel nature.

EXTENDED I.E.E. SOCIAL ARRANGEMENTS.

Arrangements have been made for the members of the I.E.E. to dine together at the Engineers' Club, Coventry Street, W., after the meeting to be held on the 1st Dec. The charge per cover is 5s. 6d. Members wishing to be present at the dinner are requested to send their names to the Sec. a day or two in advance either in writing or by telephone. Subject to accommodation being available, additional names will also be received by the Institution attendants from members when the latter sign their names before entering the Lecture Theatre for the meeting, but it is especially preferred that members should send in their names in writing or by telephone.

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Answers to Correspondents.

MR. A. BOULTON (Bargoed).—The carrying capacity of double cotton-covered wire is given, as a comparison with rubber-covered wire, in almost any wire table. It must not be taken for granted, however, when considering the wire for armature coils, that the wire used must carry the whole of the current taken or given out by the armature. This depends upon the type of winding used. Knowing this, and the input or output, then the size of wire is determined by the current *each path* through the armature has to carry.

"CRANES" (Blaine, Mon.).—We submit the following in reply to your questions:—(1) This is merely a question of design. In some cases, however, the coils are connected first in series and then in parallel for starting purposes. (2) These serve to act as interpoles. Their function is to assist the reversal of current in the armature coil under commutation. (3) We would advise you to obtain a copy of "Rotary Converters" by Mr. C. Sylvester, A.M.I.E.E., A.M.I.Mech.E., 2s. 3d. post free from this office. This deals very fully with the location of the neutral point on commutators.

Reviews of Books, &c.

[*Books noticed in this column will be sent from* ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage* (*minimum 2d.*), *and orders will be appreciated.*]

LIQUID AND GASEOUS FUELS. By V. B. Lewis. 354 pp. 59 Figs. (Constable, 12s. 6d.)—In 1907 the late Prof Vivian B. Lewes wrote an excellent book on liquid and gaseous fuels. Most of the matter was of the class which endures, but a second edition being necessary, the publishers wisely determined that recent progress should be embodied, and a revision has therefore been made in this, the second, edition by Mr. John B. C. Kershaw, who is well known for his books and writings on internal combustion engines and on fuels. The alterations made fall into three classes (1) Verbal alterations designed to make the author's meaning clearer or more definite; (2) alterations in production figures and data that have required amendment to bring them up-to-date, and (3) particulars of new methods, developments or apparatus. The added matter is confined chiefly to notes at the end of each chapter and to the appendix (which contains also useful tables of scientific data). The sections on calorimeters and on methods of enriching coal gas have been cut down to make room for the description of more up-to-date methods and apparatus. A further addition is to be found in Chapter X., where additional data and information concerning the manufacture and use of power alcohol is given. The second edition should be of more service even than was the first.

PRACTICAL ELECTRICITY. By W. E. Ayrton, F.R.S., and T. Mather, F.R.S. 548 pp. 289 Figs. (Cassell, 15s.)—We welcome the appearance of the fourth (revised) edition of this classic of electro-technical teaching on the analytic rather than on the synthetic method—a revolutionary work at its inception, but one in which the principles were so sound that it has been copied and adopted throughout the world. In the preface to the second edition in 1896 (ten years after the first edition appeared) the late Prof. Ayrton wrote: "It is not by studying geometrical optics, much less physical optics, that an infant gradually learns to appreciate the distance of objects; and later on it is not by studying a treatise on struts, nor by listening to a course of lectures on structures, that the child finds out that the table has legs, hard legs, round legs. Feeling, looking, trying, in fact a simple course of experimental investigation, gives a child its knowledge, and this, therefore, I venture to think, is the method we should adopt when commencing the study of electricity." The book has grown since then, but the principles have been rightly adhered to by Prof. Mather. As in the earlier editions, direct currents only are dealt with and the treatment does not include machinery, but it deals with most of the subjects required for the intermediate examinations in electricity and magnetism in the universities of London and the provinces. As compared with the preceding, in this edition the chief alterations have been in the rewriting of the sections on dry cells (now very complete and valuable) and accumulators. Further, the symbols adopted by the International Electro-technical Commission in 1913 have been used where convenient, and the section on practical electrical units has been revised and extended to include the most recent work on the subject. In addition, the whole book seems to have been most carefully checked over.

ELECTRIC LIGHTING IN FACTORIES AND WORKSHOPS. By Leon Gaster and J. S. Dow. 36 pp. 19 Figs. (Pitman, 6d.)—In this small treatise, the authors present, in the form of a duologue between the lighting engineer and the general manager of a company interested in a number of factories, the points in favour of correct industrial lighting in accordance with modern views of factory and workshop lighting. The suitability of different fittings and reflectors for various purposes, and the difference between general and local lighting is set forth. The best schemes for lighting the hypothetical factories imagined in the duologue are given, together with the desirable amounts of illumination. Further, the diagrams and illustrations are well calculated to appeal to the non-technical or rather, perhaps we should say, the "non-lighting-expert" reader.

METRIC SYSTEM FOR ENGINEERS. By Chas. B. Clapham. 182 pp. 28 Figs. Numerous tables. Three separate conversion charts. (Chapman and Hall. 12s. 6d.)—Like others in the D.U. (Directly Useful) series, including Arithmetic for Engineers and Mathematics for Engineers, this new volume is calculated to appeal both to students and to those in actual practice. Except for a short chapter devoted to a concise *résumé* of arguments which have been deduced for and against the compulsory legal enforcement of the metric system in the two English-speaking nations, where, of course, it is at the present time largely used, and its use is still growing, the book is given over to an explanation of the system and to conversion tables. Included are illustrated descriptions of vernier calipers, micrometer calipers, metric gear wheel calculations (with equivalent gear wheel pitches), screw-cutting calculations, illustrated examples of the use of the Amsler planimeter, etc. The chapter on compound measures is very complete and the tables of common engineering data in British and metric units are so comprehensive and well-chosen that we are sure they will be widely used by engineers. In fine, the book is a most valuable one.

The s.s. "Barrabool," a large twin-screw passenger steamer, built for the P. & O. by Harland and Wolff, Ltd., has a complete electrical installation, consisting of four main generators, in addition to which there is a vertical oil engine driving an emergency dynamo situated well above the water-line. The electrically-operated water-tight doors are all controlled from the captain's bridge, so that in the event of an alarm all doors can be closed simultaneously. Among the other electrically-driven gear is included large forced-draught fans for the boilers, refrigerating fans and large ventilation fans.

Hackney.—So the verdict has gone against the Council in the Court of Appeal in the case of Dore v. Hackney Borough Council, and we await further developments with keen interest. The leader on the subject in last week's "Review" was very lucidly written, and the last paragraph dealing with what is practically trade union tyranny expresses in a very mild way what many of us have thought for a number of years past. Possibly the action of the Executive Council of the E.T.U. in suspending the London Branch Committee (an act duly supported in the Courts) may have some influence on the future course of events in Hackney. It is evidently a case of "wait and see."

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Various Items.

N.E. Mid Electricity District.—The inquiry fixed for Nov. 29 at Sheffield has been postponed.

Fochriw.—The Powell Duffryn Colliery Co., Ltd., have terminated negotiations with the Gelligaer Council for the supply of electricity to Fochriw on account of the "unreasonable attitude of the Council on other matters." The Council are endeavouring to get the Company to reopen the negotiations.

Tenders for Trade Ship.—The directors of the Trade Ship "British Industry," of which Earl Grey is chairman, announce that provisional tenders are being obtained by the builders of the ship for the various parts and fittings. When completed the ship will go on its voyage representing the highest quality manufactures of many cities.

I.E.E. (Irish Centre).—Mr. R. N. Eaton presided at the last meeting of the Irish centre of the I.E.E., in the College of Science, Dublin, when the report of the Fuel Research Board and the report on the Water Power Resources of Ireland were discussed, the former in relation to the peat supply. Amongst the speakers were Sir John Griffiths, Professor Purcel and Professor Jeffceast.

China.—China is very much in the public eye at present, politically and industrially. Special interest therefore attaches to the B.O.T. report by Mr. H. H. Fox (Commercial Counsellor) and Mr. H. J. Brett (Commercial Secretary to H.M. Legation, Pekin), recently published by H.M. Stationery Office, at 1s. 9d. net.

Personal.—The Council of the I.E.E. have elected as an Honorary Member Lord Southborough, P.C., G.C.M.G., etc., who has rendered great services to the Institution in connection with the obtaining of a Royal Charter and Royal Patronage. Lord Southborough is perhaps better known to electrical men under his old title of Sir Francis Hopwood. He has had a distinguished career in the B.O.T. and other Government Departments. He is on the Board of Control of the N.P.L., where he has actively supported research and experimental investigation of electrical matters.

Accrington.—The minutes of the Electricity Committee show that the authorities in Blackburn have been interviewed respecting the terms upon which they would supply electricity to Accrington. Several members emphasised the great risk of serious unemployment should the existing plant at Accrington break down, and it was decided that in the event of a reply not being received from Blackburn within a few days the town's critical position should be placed before the Electricity Commissioners. Accrington have approved of the Mid-Lancs scheme for the provision of electricity, Alderman Higham stating that the whole of the area except Blackburn and Preston had assented to the scheme, and they must eventually secure the adhesion of these two County boroughs.

The Electricity Committee have received a letter from Blackburn Corporation stating the terms on which they will supply electricity or undertake a stand-by service to Accrington. The suggestion is that all current should be metered at Jubilee Street (Blackburn), and if a supply to Accrington proves necessary, to run the plant at Jubilee Street Station. At the recent inquiry by Mr. Robt. Blackmore, technical adviser, and electrical engineer to the Stalybridge-Mossley Joint Station, it was stated that by taking current from Blackburn, Accrington would lose £10,000 a year. The cost of cable laying and equipment alone will be £9,000 per mile, giving a total cost from Whitebirk of, say, £40,000 to £45,000. The Committee urge strongly upon the Commissioners the imperative need for sanction to be given to Accrington Corporation's application to borrow £150,000 for extensions, A deputation has already waited upon the Commissioners in London, and it has now been decided to send another deputation to reinfore the arguments already advanced.

The Bar Lightship.—The wireless telephone on the Bar Lightship which was licensed by the P.O. early this year for communication with the Mersey Docks and Harbour Board at Liverpool. is now equipped with the new Marconi ringing-up device which dispenses with the necessity for a continuous watch. The utility of this addition was recently demonstrated, when a towing mishap occurred off the Calf of Man. One of the tugs equipped with wireless despatched an urgent telegraphic message to its owners reporting the incident. The Bar Lightship received the communication and instantly ringing up the Liverpool Office of the Harbour Board gave a verbal account of the mishap. The telephonic message reached Liverpool some time before that received through telegraphic channels.

Blackburn.—An electrical exhibition, arranged by Mr. P. P. Wheelwright, electrical engineer, and under the direction of Mr. Goodwin, has proved most successful.

"The Electrician."—Our contemporary, "The Electrician," reached its Diamond Jubilee with the issue of the 11th, in which special articles were devoted to the changes in technical journalism and in electrical engineering practice since the appearance of the first number on November 9, 1861.

To Telegraphists.—Have you read "The Creed Pocket Book of Reference"? If not, you ought to purchase a copy at once, price 1s. 2d., post free from ELECTRICITY Office. It is a neatly bound book of 75 pp., giving full illustrated details of the Creed system as well as circuit diagrams, symbols, codes and a compendium of useful information for young telegraphists. Cheap at the price.

"Safety First" in Industry.—On Nov. 11 Mr. H. E. Blain, C.B.E., by special invitation, addressed the Industrial Council for the Building Industry, at Montagu House, on the objects and methods of the British Industrial "Safety First" Assocn., which by the use of slogans, posters and insistence everywhere upon the principles of "Safety First," claims to have reduced the number of street accidents in the metropolitan area by about 40 per cent.

Industrial League and Council.—The sixth annual report (for the year ending Sept. 30, 1921) shows concisely the magnitude of the important work in the cause of industrial harmony done by the I.L. and C., *e.g.*, over 800 public meetings have been held. During the year 250 employers and companies, 460 individual trade unionists, 24 employers' associations, and 54 trade union and trade union branches have been added to the membership, which is a good indication of the general support the League is obtaining.

"Henley" Wiring Diagrams.—Contractors and wiremen especially will no doubt welcome the pocket booklet "Hints and Diagrams on Wiring with the 'Henley' Wiring System (Twin)," published by W. T. Henley's (Blomfield Street, E.C.2), at the price of 6d. Besides diagrams of connections which are required by wiremen daily, there are others more interesting, perhaps, but not so often wanted. Further, there are useful notes on erection and some interesting particulars concerning Rawlplugs. Although published at 6d., we have been informed that Messrs. Henley's will be pleased to send one or more copies to any contractor for his wiremen free of charge.

Trade Notes.

A little booklet dealing with apparatus, switchboards and switchgear for circuits up to 150,000 volts, made by Sprecher and Schuh Co. (Aaran, Switzerland), has been sent us by **J. B. Rudkin,** at whose London office (212a, Shaftesbury Avenue, W.C.2) a representative range of apparatus, including oil switches, etc., with patent tubular framework may be inspected.

The Dyna Electric Coy. (135, Seven Sisters Road, Finsbury Park, N.7) manufacture a patented machine for charging car lighting accumulators, etc., and for re-magnetising magneto magnets. It is known as the "Dyna" magnetiser and charging dynamo, appears to be well and substantially made, and should therefore fulfil a long-felt want in garages, as chances of human error in the operation mentioned are reduced.

With the increased size of power stations the use of luminous signalling apparatus becomes more essential. Pamphlet 730A just issued by **Siemens Bros. and Co., Ltd.** (Woolwich), is therefore to be welcomed. At the time a signal is transmitted an aural warning is given. The luminous signal remains visible both on the transmitter and on the receiver, and the aural signal continues until the engine driver acknowledges the signal by operating a press button switch. As soon as this button is pressed the lamps are extinguished and the circuit to the aural signal is broken. This obliteration of the signal at the transmitting as well as the receiving end serves as an indication to the sender that the signal has been received.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
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SOME NOTES ON THE WIRELESS TRANSMISSION OF PHOTOGRAPHS.

By Marcus J. Martin.

There are several outstanding problems in connection with the transmission of photographs by wireless methods that at present await solution, the most important being the introduction of a practical working method for obtaining accurate synchronism and isochronism between the transmitting and receiving machines.

These two difficulties have only been partially overcome, at any rate as far as radio methods are concerned, and until a satisfactory solution is found, the progress of radio-photography must perforce remain more or less stationary, unless, of course, a system, based on entirely fresh principles is evolved, in which these two, at present, necessary factors can be dispensed with. With either of these conditions realised, however, wireless photography may be expected to pass at once from the laboratory to the commercial stage.

In ordinary photo-telegraphy where the two stations are connected by a metallic circuit, the solution of these two problems has been successfully overcome, but unfortunately the same methods are not applicable to wireless work; the difficulties being enormously increased where the two stations are necessarily running independently, as in radio-photography. Quite a number of devices for overcoming these difficulties have been suggested and tried, but so far none have given very satisfactory results, being either too complicated, and therefore unreliable, or depending too much upon the skill of the operator for constant adjustments.

Speed and reliability are essential qualities that will give commercial value to any radio-photographic system, and the latter can only be obtained by eliminating any unnecessarily complicated device, whatever its function. Simplicity is the keynote of success, and although at the present time photographs quite excellent from an experimental point of view can be transmitted by wireless methods over considerable distances, yet these results can only be obtained by employing synchronising devices very accurate and complicated in character, and requiring considerable skill and attention on the part of the operator to keep in good adjustment, even for a short period of time. To obtain results at all intelligible, the error in synchronism or isochronism should not be more than 1 :500 to 1 :800, 1 :1000 being nearer the mark for accurate work.

To obtain a limit of error as small as 1 :1000, the synchronising arrangements must be very nearly perfect, and to produce a device capable of maintaining this degree of accuracy for several hours together, day after day, a condition of working which must be expected and overcome if the system is to have any commercial value, is certainly no mean problem.

There are several systems of photo-telegraphy in use at the present time that are capable of giving excellent working results, but these have been designed solely for the purpose of working over metallic conductors, and to endeavour to apply these systems to radio work by the addition of a number of accurate working, delicately constructed devices, is more or less to court failure, at least from a practical point of view.

Quite recently, Prof. Belin, whose name is well known as a pioneer of photo-telegraphic work, has endeavoured to apply his system to radio working. This obviously introduces a number of complications. Not only has it been necessary to employ special and elaborate synchronising arrangements, but the greatest difficulty has been experienced in arranging the photographic transmitter to modulate the powerful output currents of the arc-generators, a large number of relays being employed for this purpose. These are obviously a likely source of electrical and mechanical trouble, besides reducing the working speed enormously. At the present time only a very simple type of transmitter has been employed, and plain black and white matter such as writing or sketches attempted, this calling for nothing more elaborate than a plain make-and-break, resulting in very decided signals of practically the same strength being transmitted. It is obvious that the degree of accuracy required, both of transmission and synchronism, for the above matter can be considerably less than if half-tone photographs were attempted. In view of the great difficulties that must be overcome in order to produce a really practical system of radio-photography, several suggestions have been made whereby the troubles already referred to can be eliminated. Unfortunately, however, these have been mostly unworkable, although one or two have proved worthy of investigation.

A particularly ingenious method, first suggested by an American, in 1910, and since experimented with by several investigators, employs a code method of transmission. Briefly, the working of the system is as follows. The picture or photograph to be transmitted is fastened upon what is known as a coding board, which consists of a small drafting board provided with a vertical and horizontal slide. These slides are graduated with letters of the alphabet, but, owing to the similarity of the telegraphic signals given to several letters of the alphabet, only seventeen out of the twenty-six are employed. It is easy to see that any point on the picture (the points are really small squares) is easily checked by simply taking a reading from both slides, each point being represented by two code letters.

The transmitting operator writes these code letters down in any pre-arranged sequence, and transmits them as an ordinary telegram. From this code message the receiving operator reconstructs the picture upon specially squared paper. In order to assist in forming a more photographic reproduction, several degrees of shading lines are employed, each shade being given a special letter which is prefixed to the ordinary code letters. By this means the operator, who must also be an artist, can obtain very good results, but these obviously depend upon the number of points into which the picture transmitted is divided, and upon the artistic skill of the receiving operator.

This system naturally possesses many drawbacks, two of the most serious being the amount of time required to transmit even a small picture of bold character, and the high cost involved. Some idea of the time required for the complete transmission of even a small picture can be obtained from the following figures. Let us suppose that a picture measuring 3 in. by 2 in., having an area of 6 square inches, is divided into a number of small portions, 1/25 of an inch square. This would mean 625 squares per square inch, or 3,750 for the complete picture. Only a very bold subject could be divided into such a small number of squares

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with any prospects of intelligent transmission, although this number is considerably less than one quarter of the number of points contained in a newspaper illustration of the same size. Estimating two code letters to each point and four telegraphic signals to each letter, this makes a minimum of 30,000 signals to be transmitted. Even with the high working speed of 125 letters, or 500 signals per minute, the time of actual transmission would be 60 minutes; and assuming that 4 hours would be required for the processes of coding and reconstructing the picture, the time for complete transmission, from start to finish, would be quite 5 hours, and this for a very small and simple picture.

It is easy to see that any attempt made to transmit a large picture containing any very fine detail by this method would necessitate dividing the surface into an enormously large number of points, and these, when reduced to signals, would take a length of time to transmit that would preclude the system from developing any real commercial value, even if the present cable rates did not render the cost prohibitive.

The whole process could, no doubt, be improved, and the working time considerably shortened, by the introduction of a simpler and more efficient method of coding, thus reducing the total number of signals required. Automatic high-speed wireless will also tend to reduce the time and cost of transmission.

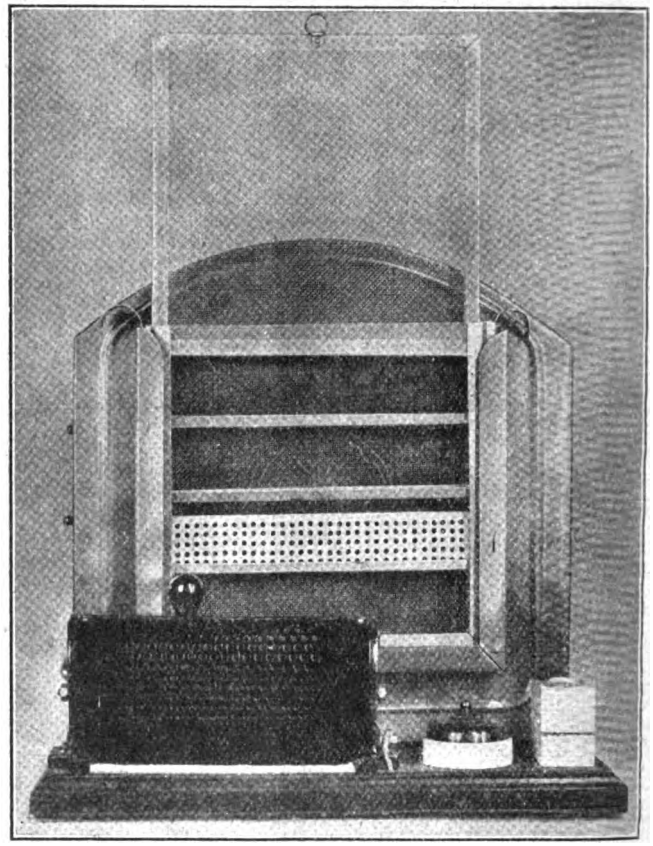
Whether this system will ever acquire a commercial value, time alone will prove, but it is evidently capable of much greater development. Wireless photography, however, has yet a long way to go to equal the results obtained by photo-telegraphy over metallic conductors, but the problem is being steadily attacked, and sooner or later the solution will yield to organised experimental research.

THE "WIN-SUM" RADIATOR.

This appliance is designed for the distribution of heated, normal temperature, or cooled air, charged with disinfectant or aromatiser. It is thus suitable for use all the year round in homes, offices, schools, hospitals, public buildings, etc., and deserves its name of the "Win-Sum" (Winter-Summer) Radiator. It is simple in construction, artistic in design and can be "finished" in any style. The radiator illustrated measures 16 in. by 14 in. by 15 in., and is fitted with four independently controlled heating elements of one or two units capacity. A current of air is drawn over these elements by means of a quiet fan running at about 900 r.p.m., max., and taking 40 watts—a regulator is provided for speed adjustment. In the container at the rear of the appliance are porous perforated slabs through which the air is sucked by the fan and in passing takes up the disinfectant or aromatiser with which they are impregnated prior to passing over the heating elements. A feature of the design is a baffle plate between the fan motor and the heating elements. This acts as a heat deflector and also serves to prevent the motor overheating by preventing a reverse current of hot air being drawn to it by the fan.

It will be seen from the above that the appliance can be used in a variety of ways as the heating elements, fan and porous perforated slabs are all separately controlled.

To re-impregnate the slabs they are soaked in cold water, dried and then charged with the solution desired. By the addition of a collapsible cupboard with perforated back, clothes can be dried and aired rapidly, while by the attachment of an ice chamber the applance becomes invaluable for use in tropical climates, sick bays on board ship, etc. The "Win-Sum" Radiator is patented and manufactured by Tidd Siday and Co., Ltd. (180, Drury Lane, W.C.2), to whom we are indebted for facilities of inspection and demonstration.



END VIEW OF "WIN-SUM" RADIATOR.

THE HAIGH ALTERNATING STRESS TESTING MACHINE.

An accurate and simple machine for carrying out tests on the gradual fatigue of metals under alternating stress is manufactured by Bruntons, of Musselburgh, Scotland, under Patent No. 124100 of Professor Haigh, who developed it in the course of several years' research in the Royal Naval College, Greenwich.

The machine stands about 5 ft. high and occupies comparatively little floor space. Test pieces up to 15 in. in length can be dealt with, and ample clearance for special tests, *e.g.*, to allow of an electric furnace being placed round the test piece for tests at high temperatures, is pro- The range of stress can be varied up to 1½ tons.

The action of the machine depends on a pair of electro-magnets, supplied with two-phase currents from a small alternator. The forces generated by these magnets, pulling on opposite sides of a single armature, are transmitted to the lower end of the test piece, the upper end of which is gripped in a holder that forms part of the adjustable head. The magnets and adjustable head are rigidly connected by four vertical columns that form part of the main frame of the machine. All stresses being self-contained within this frame, no considerable vibration is transmitted to the foundation. The vibrating armature and connecting rods being guided by springs, without the use of lubricated slides or bearings, the machine is almost silent in its opera-

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tion. The frequency of reversal of stress is governed by the speed of the alternator, and is usually 2,000 stress-cycles per minute—corresponding to 1,000 r.p.m. Each cycle of stress includes one pull and one push.

Although the majority of tests are performed with stresses ranging between equal intensities of pull and push, the ratio between the extremes may be varied at will through suitable springs which serve the further purpose of compensating the force required to accelerate the armature and its fittings in their small but rapid vertical movement. The spring stiffness may be adjusted, by the use of clamps, to suit widely different frequencies of operation.

The alternator has three slip-rings, leads from two passing through the differential ammeter coils in the stress-meter. The lower stress-meter terminals are connected to the testing machine through a separate choking coil without any external source of supply. The terminals of the automatic release are connected through a pilot lamp and a coil in the main switch to the exciter or D.C. supply; and the same D.C. source supplies the alternator field-circuit through a pair of field rheostats.

In standard sets the main switch serves to disconnect the testing machine from the alternator, and must be closed *before* the voltage is raised, since, otherwise, the test-piece will be overstrained when the switch is closed. When the switch trips on the completion of a test, the counter is disconnected from the alternator and must be reset before starting the next test. In motor-driven sets, the main switch is not required in the two-phase circuit and may be used to open the motor supply circuit. The counter can then be permanently connected to the alternator, which may be placed in any convenient position without reference to the switchboard. The automatic release, provided for the purpose of shutting off current when the test-piece breaks, is actuated by a small trigger attached to the vibrating armature.

An important advantage of this type of machine lies in the uniform distribution of the alternating stress across the full section and along a considerable length of the test-piece. In many other methods of testing, by means of bending stresses, it has not been possible to determine the fatigue limit with accuracy because the test-piece cracks at a fillet when the intensity of stress was indefinite. The new machine obviates that difficulty and may be applied in wider fields of research to test models of machine parts as well as simple test-pieces of different materials, or of the same material with different heat-treatments or degrees of cold-work.

Machines of this type have been supplied to the N.P.L. at Teddington; R.A.F., Farnborough; the Universities of Edinburgh, Birmingham, Sheffield, and others.

LIGHTING A DRAWING OFFICE.

There has always existed considerable diversity of opinion as to the best method of lighting a drawing office, not only among illuminating experts, but also among draughtsmen and works managers. Broadly speaking, the choice lies between general lighting by indirect or semi-indirect bowl fittings and local lighting with individual adjustable lights well screened in direct type reflectors.

The advocates of general lighting lay stress on the very uniform and glareless illumination which can be obtained with this system if properly designed and installed and the absence of shadows which results from perfectly diffused indirect lighting. They also point out that excessive contrast is apt to occur in a local lighting system and that inconvenient shadows are often thrown by direct type units unless great care is exercised in placing them.

Many draughtsmen, on the other hand, contend that a carefully adjusted and shielded local light is more comfortable and convenient, while works managers, who are somewhat apt to be influenced by the question of cost, often claim that the acknowledged benefits of indirect lighting do not warrant the higher running costs of this system, and that the cheaper method of providing the necessary high intensity (8 to 12 foot candles) over the drawing boards by local lights is sufficiently satisfactory in most instances.

In view of these conflicting opinions it is interesting to learn that in at least one big works all the engineers' and drawing offices have been converted to indirect lighting by high candle-power gasfilled lamps. The buildings in question are attached to the Dowlais Works of Messrs. Guest, Keen and Nettlefold, near Merthyr Tydfil, and are lofty and spacious. For the main drawing offices an intensity of 8 foot candles was specified, and for the engineers' offices, 6 foot candles. The installation was designed by the Illuminating Engineering Dept. of the General Electric Co., Ltd. (Cardiff Branch), the fittings being manufactured by the Company. Those in the drawing offices are white enamelled steel bowls fitted with internal mirror-glass reflectors, while for the private offices a more decorative design in bronze is employed. All the lamps are 300-watt, gasfilled Osrams. Photographs, which have been taken, show in a convincing manner the uniformity, good diffusion and absence of shadows.

ELECTRICAL PROGRESS.

METHODS DISCUSSED AT THE I.E.E. INFORMAL MEETING.

The new session of the Informal Meetings of the I.E.E. was inaugurated at the Embankment Headquarters on Monday, November 7, when the chair was taken and a discussion opened by the President, Mr. J. S. Highfield, on "How Best to Speed Up Electrical Progress." There was a large attendance, the discussion being lively and interesting and admirably fostered by the Chairman, who defined electrical progress as a condition where everybody who wanted a job could get a job. To reach this happy state, we must get our services appreciated and find out what is appreciated. It is no good thinking of easy profits, it means hard work and good service. As an example of how not to do it, take the recent history of the coal trade. At the time of the Armistice, the French and Italians were badly needing coal, and if the coal industry had put their backs into it we might have had the goodwill of those nations. Instead, the situation was greedily exploited to the very utmost, and what resulted? The Frenchman having got back his mines in Alsace, and the Italian counting up his water-power resources, resolved to avoid buying our coal at all costs, and the industry, instead of flourishing, is now in a state of lamentable depression. If we took care that the demand for electricity all over the country was in every way fostered by good service and honest efforts to cheapen supply, there was a wave of prosperity just ahead of us.

Bearing on the efforts to cheapen supply, the President gave some serious figures of the past and present labour output and the cost of materials. Noting that it costs three to four times the old rates to connect a consumer, he pointed out that the small lighting service with low current lamps might be years in proving a source of revenue to a system. He thought, therefore, we should induce a customer to extend as far as possible the use of small apparatus, that is irons, toasters, etc., all of which might be served by the existing house wiring and single meter, but charged on the two-part tariff system. On this point it was very desirable that journeymen electricians and supervisors should be better trained in a knowledge of advocacy of electrical appliances.

Mr. A. F. Harmer, who led the subsequent discussion, thought it delightful that the President should say in effect that the I.E.E. Wiring Rules are an abomination. They too often obstruct operations and cause unnecessary expense.

Mr. E. T. Williams wanted more advertisement, and thought that Supply Authorities might familiarise their wares by means of the cinema. By all means get our convenient appliances known and tried; a great deal of business could yet be done by hire purchase methods.

Major T. Rich thought it imperative to simplify all

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systems to the minimum compatible with efficient service. Some concerns seemed anxious only to go on multiplying unnecessary gadgets, and he instanced cases of motor control gear costing more than the motor.

Mr. W. L. Wreford spoke of the vexatious regulations of some Supply Corpns. Many of their restrictions are ridiculous and without any legal authority. He thought it desirable that there be issued an abridged edition of wiring rules and regulations giving a digest of the authorised conditions in connection with electrical supply.

Mr. W. Dargavell thought technical language should be avoided in transactions with the layman. Electrical apparatus should be marked in terms easily readable. Why not retain the now familiar "unit" rating of house meters instead of changing to "kilowatt hours" as required by the B.O.T.?

Mr. W. E. Warrilow thought we ought not to preach to the layman until we were ourselves good consumers. He wanted to know how many at the meeting were actual consumers of electricity for lighting, heating and cooking. In his inimitable manner he informally got a show of hands from the meeting on these three degrees of faith, and it made a very creditable showing. The President declared that he had used electric cooking for twenty-five years, and in spite of discouragement and defects that still exist, his household felt it was far ahead of any other method of cooking.

Mr. F. Pooley said the answer to the question implied by the title of the discussion was, shortly, "Remove the restrictions, legislative and executive, by which the industry was shackled"; and it was up to the young men in the industry to carry on a campaign with that object in view.

Messrs. P. S. Fox, M. Farrer, G. L. Addenbrooke, A. B. Eason, W. G. Johnson, W. E. Rogers, A. D. Chamen, J. R. Bedford, and W. C. Kennett also spoke before Mr. J. S. Highfield closed a capital (and really informal) meeting with a masterly summary of the points raised, and we got a hint that the onerous wiring rules might be revised shortly.

LIGHT AND PUBLICITY.

An Interesting Example of Hoarding Illumination.

The illustrations herewith show posters illuminated by B.T.-H. Floodlight Projectors. The three posters seen in Fig. 1 occupy an area 55 ft. long by 15 ft. high. Five projectors are mounted on the top of a blank wall on the opposite side of the road about 9 ft. high, and are so disposed and directed that the five separate beams of light cover the area with an intense and uniformly distributed illumination. Type 786 projectors, fitted with mirror reflectors and Mazda gas-filled lamps, and mounted on universal brackets, are employed. This form of mounting allows the projector to be swivelled in any horizontal or vertical direction. These projectors are completely weatherproof, and are intended for use in exposed positions.



FIG. 1

To light a hoarding in the manner illustrated is doubly advantageous. For one thing, it makes the advertisement readable; and this alone is sufficient justification of the relatively small expense involved. In addition, an illuminated poster, by reason of the contrast with the surrounding gloom, possesses a glamour and a publicity value greater than in the daytime. In other words, the flood-lighting of hoardings must be considered as something more than a means of extending the period of visibility, as it also has the effect of making the advertisement stand out with an individual distinction not otherwise attainable.

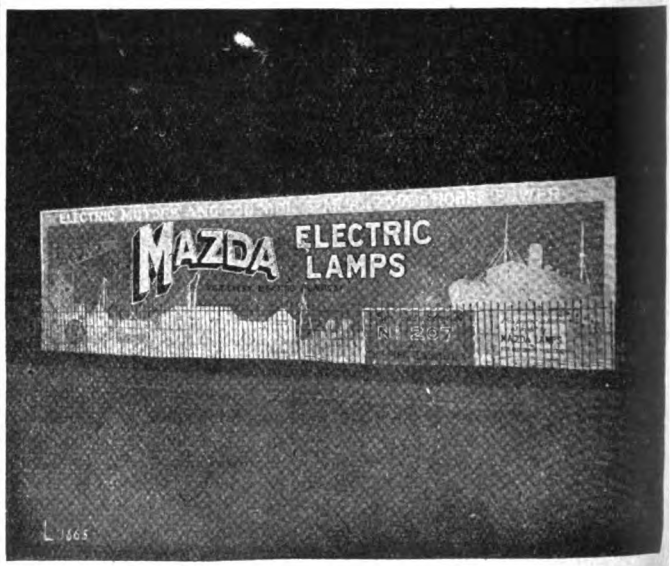


FIG. 2.

Flood-lighting in this country has been developed by the illuminating engineers of the British Thomson-Houston Co., Ltd. (Rugby, and 77, Upper Thames Street, E.C.4). These engineers have studied the question in all its aspects, and have designed a range of projectors for the various purposes and conditions to which flood-lighting can be applied. Poster illumination is merely one of many applications. For example, there are many industrial conditions in which flood-light projectors can be advantageously employed —such as the illumination of factory yards, dock-yards, goods yards, etc., and for the spectacular lighting of monuments and buildings flood-lighting is at once the simplest, the most economical and the most effective method.

Algeria.—The report on the economic and commercial situation up to August, 1921, by Mr. J. K. V. Dible, Acting British Consul-General, is now available from H.M. Stationery Office, price 2s.

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PAGES FROM OUR DESIGNER'S NOTEBOOK

WESTON ELECTRICAL INSTRUMENT CO LTD

WESTON PRECISION IN INSTRUMENT MANUFACTURE

A FEW POINTS ON DELICACY OF WORKMANSHIP.

It is well known that Weston Electrical Instruments owe their pre-eminent position partly to the high class of workmanship put into every part, but in order to demonstrate exactly what this amounts to, the following details are given :—

The Standard moving system of Portable d.c. Instruments, Model 1, consists of 12 parts, the total weight of which is about 24 grains (1.5 gramme).

In some Weston Instruments the total weight of the moving system is 8 grains, and in others, 4 grains (.25 gramme).

The wire of the voltmeter moving coil ranges in diameter from 1/1,000 in. to 4/1,000 in., *i.e.*, from one-third to the actual thickness of the average hair.

In the Power Factor Meter, Model 215, the conducting filaments run 16,000 to the ounce, while the heaviest ammeter springs run only 232 to the human ounce.

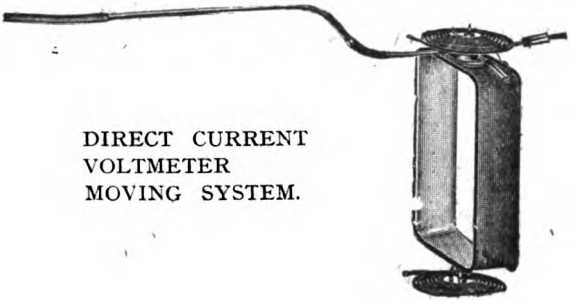
Pivots vary in size, but the smallest have a diameter of 10·5 thousands of an inch, being of highly tempered special steel, ground separately on jewellers' lathes and inspected under the microscope.

AUDREY HOUSE · ELY PLACE · LONDON · E.C.1

All pointers are tubular, and the thickness of the metal ranges from 1/1,000 in. to 6/10,000 in.

The balancing arms, which are of aluminium, are threaded with 272 threads, and in some cases, 500 threads to the inch.

The latter is the finest thread ever cut in aluminium and as stock of the necessary degree of fineness cannot be obtained commercially, the tubes are specially drawn in our own works.



DIRECT CURRENT VOLTMETER MOVING SYSTEM.

It would be utterly impossible to work to such limits as the above, and to sell at a reasonable price, but for a very exceptional factory equipment of special tools. In this respect the WESTON factory is unique, while the standardising and investigating laboratories rank among the best in the world.

For full particulars write for Catalogues.

Greenly's

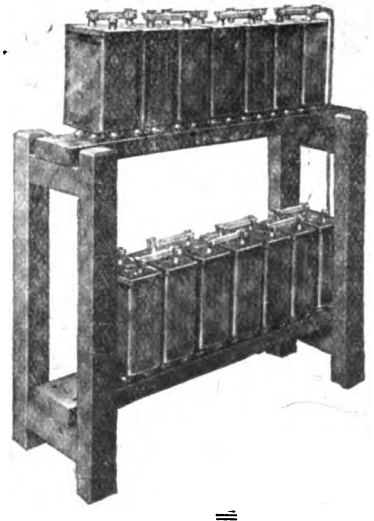
ELECTRICITY

IN THE COUNTRY HOUSE.

In isolated places, country homes, clubs, hotels, etc., can have all the comforts of Electric Light and Power from small, self-contained plants.

The battery carries the burden of the load on these plants. It is the heart, the vitals, the mainstay of the whole system.

Get the right battery first time. Chloride batteries are specially designed for this work. The largest factory in the kingdom making Storage Batteries only, and the widest organisation for the care of batteries in service is at the back of every Chloride battery used.



THE Chloride ELECTRICAL STORAGE COMPANY LIMITED

Clifton Junction, Manchester.

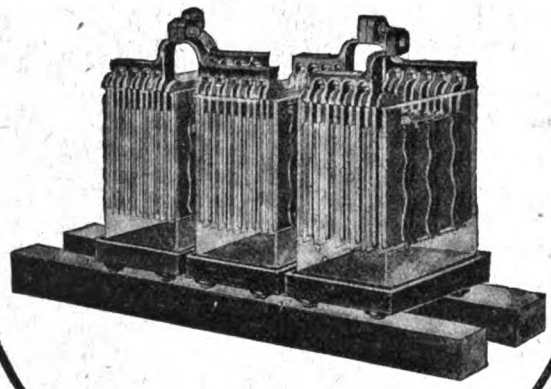
57, Victoria St., London, S.W.

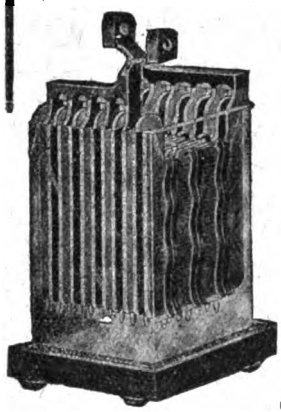
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BY INSTALLING
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EASY TO MAINTAIN.

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MARSHGATE LANE, STRATFORD, LONDON, E.15.

BRANCH OFFICES AT—

LONDON	36, Victoria St., S.W.1.	BIRMINGHAM ..	30, Lincoln's Inn. 174, Corporation St.
GLASGOW	107, Wellington Street.	BRISTOL ..	37, Victoria Street.
MANCHESTER	4, Victoria Bridge.	BELFAST ..	Scottish Temperance Bldgs., Donegall Square.

BY APPOINTMENT

ANNOUNCEMENT

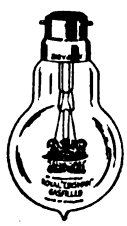
WE have pleasure in announcing that as a result of recent experiments and developments we are now able to manufacture the following new sizes of Gasfilled Lamps.

100/130 volts 30 watt ... ... 4/- each.
200/260 volts 40 watt ... ... 5/- each.

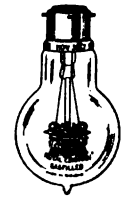
Royal "Ediswan" Lamps will therefore be available for all Domestic and Industrial Lighting conditions.

Order now for delivery on and after December 1st.

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71, Victoria Street, S.W.1.
Branches in all large towns.



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"EDISWAN"
GASFILLED LAMPS.
Fully Licensed under Patents No. 23499/09, 10918/13 and others.



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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

Dundee Enterprise.

Among the few towns in the British Isles which have endeavoured to popularise electricity for domestic purposes, Dundee may fairly claim to belong, by virtue of the energy and enterprise of the Electrical Engineer, Mr. H. Richardson. Some time ago, it will be recalled, what is known as the Two-part Tariff of charging for electricity consumed was introduced, as an inducement to householders to extend their use of electricity for purposes other than mere lighting. This two-part tariff comprises a fixed sum per quarter, based on the area of the house plus 7-8 of a penny per unit for all electricity consumed, whether for lighting, heating or cooking. To date the response has not been such as to justify the departure from conventional methods of charging for electrical energy, and, assuming that the apathy of the householders is mainly due to the present cumbersome and costly method of wiring houses for electricity supply, the Dundee Electricity Department has initiated another experiment.

Selecting for its object lesson a seven-roomed house in Broughty Ferry, including the usual scullery, kitchen, and bathroom, the Electricity Department have wired this on a cheap, direct, surface plan, applicable to all types of dwelling house. In the model system, which is now available for inspection, the conductors are run along the walls and supported by clips, at about the height of the doorways in the various rooms. The usual ceiling fittings are dispensed with, and wall brackets adopted in their place, together with a species of inverted fitting which gives very satisfactory indirect lighting by reflection from the ceilings. Among the advantages claimed for the system are low cost, easy extension, a minimum of cut-outs, and rapidity of installation with the least possible disturbance of furniture or decorations. Taken in conjunction with the admitted advantages of the two-part tariff, this venture should give a fillip to domestic electric service in Dundee, and Mr. Richardson is prepared to issue suitable quotations to any interested consumer.

Municipal Trading.

Apropos of my recent comments on the need for closer co-operation between municipal supply authorities and the local electrical trade towards a common object, the increased use of electricity for domestic services, I see that the injunction sought by a body of Liverpool traders against the Liverpool Corporation to restrain the latter from carrying on the business of providing electrical fittings and wiring premises for electricity supply has been refused by Mr. Justice Russell. Although sympathising with the traders concerned upon what they doubtless consider an unwarrantable competition with their interests as local electrical traders and ratepayers supporting the supply undertaking, I nevertheless hope that the result will prove of ultimate benefit to residents.

Liverpool does not rank among the most progressive cities in the matter of popularising electricity supply, a fact which may be due to lack of enterprise in two directions, as represented respectively by the Supply Department on the one hand, and by the local electrical trade on the other. I have never heard of any Liverpool district being canvassed on the subject of electricity supply, nor would it appear that the local traders are over-zealous in playing their part in the education of the public on the merits of domestic electric service. If the outcome of the legal proceedings is to bring both parties together in a united effort to swell the ranks of Liverpool consumers, much will have been accomplished, and I would counsel a *rapprochement* on this basis.

Scamped Workmanship.

Those who were fortunate enough to visit the recent motor show at Olympia and the White City were doubtless impressed by the growing convenience and incidentally, the increased complexity of the electrical equipment of the modern motor car. With electric starting, lighting, heating, ignition, and other incidental duties to perform, the modern electrical equipment of an up-to-date motor vehicle is ever becoming more and more ingenious and labour-saving. In keeping with the high-class finish of most cars the visible portions of the electrical gear are similarly attractive to the eye, and it is only when one comes to examine more closely into the hidden detail, or experience its vagaries in everyday use on the road, that one realises how much the exponents and designers of motor car electrical gear have yet to learn before they can lay claim to have perfected this feature in modern car equipment.

It is significant that most of the troubles one meets with among the motoring fraternity to-day have to do with the electrical gear, and, analysed down, are due either to faulty design, inaccessibility, or poor workmanship. To give an instance, I saw a lighting switch dismantled the other day, the process being an object lesson. It was fitted to the polished hardwood dash of a modern car and had four positions, "Off," "Full," "Dim," and "Charge," the idea being that by turning the aluminium milled disc the two headlamps could be connected either in series or parallel for full and dim effects respectively, whilst a fourth position switched the battery on to the dynamo for charging during the hours of daylight.

Theoretically, the idea was quite sound, the necessary switch movement being simplified down to the mere turning of a knob until a pointer stood opposite and indicating the desired condition. Trouble arose, however, and it became necessary to investigate. Symptoms pointed to the switch as the offender, and difficulties were apparent at the outset. It was im-

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possible to get at the back of the switch without unscrewing the dash, and on removing the screws securing the latter it transpired that only an inch or two of movement was possible owing to the anchorage of short wiring. The next step was to remove the switch knob, and this proved to be screwed, *and pinned,* to the switch spindle, an extension of the pin forming the index finger for indicating the switch position.

By mutilating the knob beyond repair it was eventually detached from the spindle, permitting the dash to be removed and the actual switch mechanism exposed to view. This proved to be a cylindrical ebonite box with a loose disc cover, also of ebonite, and in which the switch spindle revolved as a bearing. Rough brass pegs were secured to the sides of the box interior by outside nuts, which also acted as terminals for the wiring, the switch blades being fan-shaped brass segments of doubtful springiness and with no definite limitations as to radial or axial position. The whole construction was most amateurish and practically bound to give trouble before it had been in use a dozen times, yet it bore the name plate of a popular maker of such equipment. Design was lacking, workmanship was poor, and the net result was a very disgusted owner. From other examples I have come across I surmise this case is only one of many similar instances of scamped electrical equipments which will ultimately bring this branch of the industry into disrepute.

Cheap Coal

It is interesting to note the evidence which has been submitted by experts in connection with the introduction in this country of mechanical (and electrical) coal cutting and getting machinery. It is employed in the United States and Canada to a far greater extent, and—quoting Mr. Browne's report :—" This is due to two causes, partly because the physical (*i.e.*, geological) conditions under which coal is worked in America are better, and also because American labour has grasped to a far greater extent than labour in this country the fact that the soundest route to improve its position is to get the maximum output per unit of labour employed compatible with health and safety, either by direct manual labour or the help of machines."

The mining leaders will not like the second clause in the above quotation. It is equivalent to saying that the British miners and their leaders are dunderheads, and do not want to improve their position. Of course an increase in the demand for electrical coal cutting plant is good for our trade, so I hope that there will be more rapid developments in the near future. Already miners are increasing the output per man, and the cheapening in cost which is thereby effected is sure to improve the general outlook. That is good for the whole country, so "more power to their elbows," say I.

ELEKTRON.

Batti-Wallahs.—There is to be an excellent Smoking Concert at the Engineers' Club this evening, and it is most urgently to be hoped that Batti-Wallahs will turn up in force, accompanied by one or more guests. Those holding tickets (price 2s. 6d. only), are free to dine at the club and enjoy its privileges for the evening. We sincerely hope that Mr. A. J. Greenly, Hon. Entertainment Sec., 37/8, Strand, W.C.2, will this time obtain the support his energies deserve.

ELECTRICAL ENGINEERING—FINAL GRADE.

Solutions to Questions set at the 1921 Examination of City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page* 618.)

Q. 7.—Define " dielectric strength." What is meant by the statement : " air is a good insulator, but a relatively poor dielectric " ? What effect have the insulating and dielectric properties on the kind of insulation used in high-tension machines and cables ?

A. 7.—The *dielectric strength* of an insulator is the maximum voltage per unit thickness which a dielectric can stand in a uniform field before it breaks down electrically. It is usually stated in kilovolts per millimetre thickness.

It does not follow that because a material has a high insulation resistance, it has also a high dielectric strength ; for example, air has practically an infinite resistance, but it breaks down at the comparatively low voltage of 3 kilovolts per millimetre. Mica, on the other hand, has an insulation resistance of the order of 10×10^6 megohms per cm.^{3}, but it has a dielectric strength of about 20 kilovolts per m.m. In fact, most insulators have a dielectric strength well above that of air, but do not possess nearly such a high insulation resistance. Hence the reason for the statement that " air is a good insulator but a relatively poor dielectric."

If a conductor be surrounded by a homogeneous insulating material which in turn is enclosed in an earthed metal sheath, it can be shown that the potential gradient (*i.e.*, the voltage drop per m.m. radially) at any point in this insulation is inversely proportional to the radius at this point, so that the potential V between the inner and outer conductors is distributed roughly as in Fig. 11. Since the voltage drop per m.m. is greatest at the surface of the central

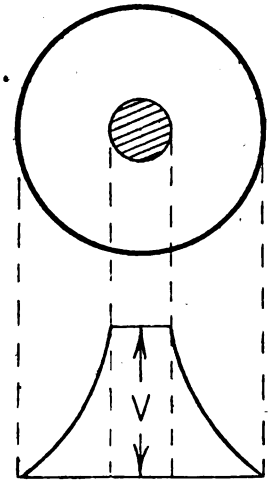


FIG. 11.

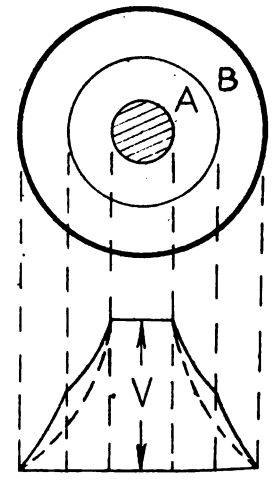


FIG. 12.

conductor, this is the point at which the insulation breaks down first, and so the material must be chosen and the diameter of the core must be such that the maximum potential gradient is well within its dielectric strength. In such cases, the insulation resistance of the dielectric is always well above that required to limit the leakage current to a negligible amount.

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If the external diameter of the insulator were increased, say, ten times without altering the diameter of the core, it would be found that the maximum potential gradient would only be reduced to a half of its original value. The safe working voltage of a cable of given dimensions can be increased by *grading* the insulation, *i.e.*, by making the insulation in two or three layers of materials having lower *specific inductive capacity* (S.I.C.) the further away they are from the central conductor. Thus, if *A* in Fig. 12 has a S.I.C. of, say 6, and *B* of 3, the potential gradients in *A* and *B* are roughly as shown in the lower half of Fig. 12. From a comparison with the potential gradient in a homogeneous material (shown dotted), it is seen that the potential is now distributed more evenly over the insulation, and therefore risk of breakdown at the point of maximum potential gradient has been greatly reduced.

In the case of high-tension machines, the limitation of slot space renders it imperative to use an insulator having both dielectric strength and insulation resistance of a high order; and for such a purpose, either a tube of moulded micanite or a wrapping of mica and oiled linen is very suitable. Another point to be remembered concerning slot insulation is that the greater the number of layers of the insulating material for a given thickness, the higher in general is its breakdown voltage, due mainly to the fact that any weak spots in successive layers rarely coincide in position.

(To be continued.)

TELEGRAPHY.—GRADE I. (1921).

Being Solutions to the Questions set by the City and Guilds of London Institute in the Grade I. Examination in Telegraphy held in April, 1921.

(Continued from page 632.)

*Q.*11.—Explain the principle of differential duplex working. Give a diagram of two stations double current duplex and show by means of arrows the direction and also the relative values of the currents in the line and in the batteries and compensation circuits when both keys are depressed. How are the marks produced at both stations?

*A.*11.—Fig. 4. Illustrates the principle of the opposition method of differential duplex working.

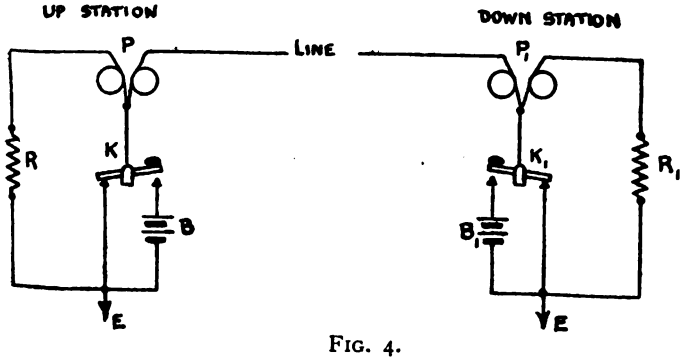


FIG. 4.

$P P_1$ are relays differentially wound with wires of equal length and resistance, and RR_1 are artificial resistances equal to that of the line.

When the key at the up-station is depressed, the current divides at P, half passing to the line and half going by way of R. The line current flows through one coil of the relay P, through K_1 to earth, and back to the negative pole of the battery B. Since equal

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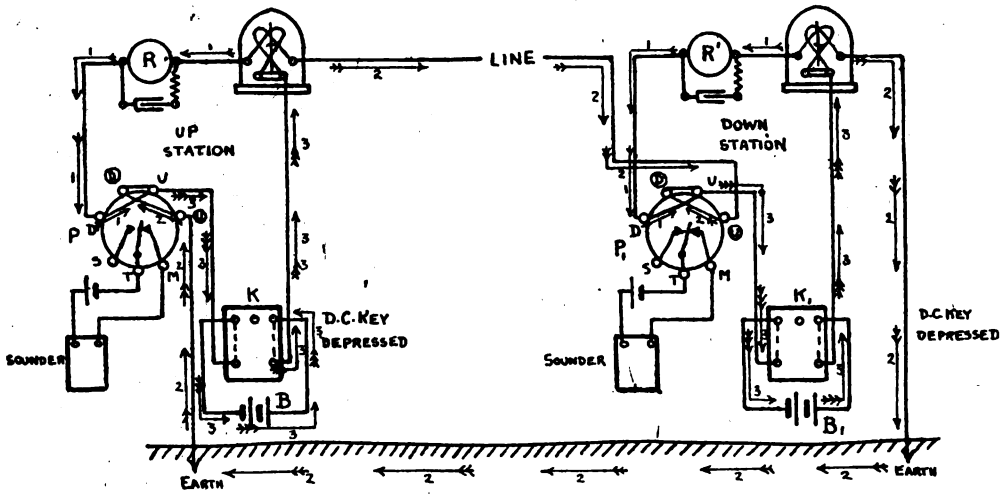
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currents flow through the coils of the relay in opposite directions no effect is produced on the home relay P, but as the current traverses only one coil of the relay P_1, a signal is registered.

In the same way, if the key K_1 at the down station is depressed, relay P_1 is unaffected and relay P is actuated.

When both keys are depressed simultaneously, the currents oppose each other in the line, and *the currents flowing in the compensation circuits operate the relays.* Thus when both keys are depressed, the relay at each station is actuated by the current in its own compensation circuit *in the same way as if the current from the other station were received.*

FIG. 5



It has been assumed that the line and compensation currents are equal, that the batteries oppose each other in the line, and that the current splits once only at either end. In practice, however, the batteries are usually connected to act in conjunction (*combination* method), in which case the current in the line is double that in each of the compensation circuits. Moreover the current splits twice, viz., at the galvanometer and the relay, this is shown in Fig. 5, which represents diagrammatically two stations double current duplex. The arrows with numbers alongside indicate the direction and relative values of the currents throughout the circuit when both keys are depressed.

When both keys are depressed simultaneously, the batteries unite to make both relays mark. The current from the up-station flows to up galvanometer, half going through the compensation circuit, the other half through the line, from U circle to D circle of the down relay (producing a mark), through battery B_1, down galvanometer, back by earth, from U circle to D circle of the up-station relay (marking direction) to the negative pole of the up-station battery. The current from the down-station battery flows to galvanometer by earth to the up-station relay, from U circle to D circle (marking direction), through battery B to up galvanometer line, and down-station relay (marking direction) back to the negative pole of B_1. Thus the current in the line circuit is double that in each of the compensation circuits, and the marks produced on the relays are due to the preponderance of the current in the line circuit.

(*To be continued.*)

NOTES ON WATER POWER DEVELOPMENT.*

BY PROF. A. H. GIBSON, D.Sc.

The technical development of electric generation and transmission has made it economically possible to utilise powers remote from any industrial centre, while a rapid increase in the demand for energy for general industrial purposes and for the many electro-chemical, electro-physical, and electro-metallurgical processes which are now in general use, and whose field is rapidly growing, has provided a ready outlet for all such energy as could be cheaply developed.

The urgent demand for energy to supply the abnormal requirements of the war period, combined with the world shortage of fuel, was responsible for an unprecedented rate of development in most countries with available water power resources, and especially in those countries normally dependent on imported fuel.

Thus in France some 850,000 water h.p. has been put into commission since 1915, and the country now has 1,600,000 h.p. under control as compared with 750,000 before the war. In Switzerland some 600,000 h.p. has been developed since 1914, or is in course of construction, as compared with 880,000 h.p. before the war. In Spain, where the pre-war output was 150,000 h.p., the present output is 620,000 h.p., and about 260,000 h.p. is now in course of development, while the Spanish Ministerio de Fomento is considering the development of some 2,000,000 h.p. to be delivered into a network of transmission lines covering the industrial parts of the country.

In Italy, schemes totalling about 300,000 h.p. are under way, and it is estimated that the total output will shortly amount to 2,000,000 h.p. The Govt. Hydrographical Dept. is now engaged in gauging and surveying the profiles of the principal rivers, and statistics of available reservoir sites of lakes suitable for storage, and of available horse-power are being compiled.

Japan, which only very recently began to investigate her water powers, has, since 1916, developed over 1,000,000 h.p., or almost twenty per cent. of her available resources.

In Canada and the U.S. many large schemes have recently been brought into service, and some extremely large installations are now in course of construction or are projected. Thus the Queenston-Chippewa project on the Canadian side of the Niagara River is intended to develop some 500,000 h.p., while a projected development of the St. Lawrence River will be capable of yielding 1,700,000 h.p. In Canada the total development (2.3 million h.p.) in 1918

*Abstract of address by the President of the Engineering Section, British Association, at Edinburgh, 1921.

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was almost three times as great as in 1910. In the U.S. the development has increased from something under two million h.p. in 1901, to 5.3 millions in 1908, and to nearly 10.0 millions in 1920.

Rapid as has been the development of water power in the U.S. in the past, it has been retarded by the fact that the privilege of using the national forests or other public lands for water power development has only been granted by the issuing of permits which were not available for any definite period and which were revocable at the will of the Granting Authority. In the case of development on navigable streams, whether on public or private land, each scheme has required a special Act of Congress, and these Acts could be revoked by Congress at any time. Owing to the uncertainty of tenure there has naturally been some reluctance to invest capital in such undertakings.

By the recent Federal Water Power Act, signed in June, 1920, licences for such developments may now be issued under the jurisdiction of a new body, known as the Federal Power Commission, for a period not exceeding fifty years, at the end of which the licence may be renewed, or the Government may take over the enterprise upon compensation of the licensee. In the issuing of licences, preference is to be given to State and Municipal applications. The effect of this Act may be inferred from the fact that, within a month of its being signed, applications for licences to develop over 500,000 h.p. had been filed. The duty of collecting, recording, and publishing data regarding the utilisation of water resources, the water-power industry and its relation to other industries, and regarding the capacity development costs, and relationship to possible markets of power sites, has also been assigned to this Federal Power Commission.

World's Available Water Power.—During the past few years much attention has been paid to statistics of available and developed water powers. In the case of developed powers, these are usually stated in terms of the capacity of the installed machinery. This machinery is, in general, only used to its full capacity over a portion of each day, although in many such cases water is available for providing continuous power if desired.

Estimates of potential power are always to be accepted with considerable reserve. In order to make a reasonably accurate estimate, the run-off from the catchment area and the variation in this run-off from month to month and from year to year, must be known, and it is only in comparatively rare cases that this information is as yet available. Moreover, there is as yet no standard basis on which potential power is computed.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

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Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 130.

Recently, I had cause to test two new 200 volt, 6 h.p., direct current motors. These are shunt machines, two poles, but the windings round the poles are connected in parallel. The rated speed is 1,400 r.p.m. On test the speed is 1,420 r.p.m. at full load, and 1,300 r.p.m. at no load. If, at no load, the rocker is moved to bring the speed up to 1,400 r.p.m., when the load is placed on the machine the machines race away as though the field was broken. Can any reader tell me why this should be, and what the remedy is?.—"TESTER."

(Replies to Question No. 130 must be received not later than December 10, 1921.)

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]*

HARDENING AND TEMPERING ENGINEERS' TOOLS. By G. Gentry. (Percival Marshall. 9d. net.)—This is No. 9 of the "Model Engineer" series of handbooks with which Mr. Marshall has endeavoured to satisfy the cravings for knowledge of so many thousands of the younger (and also elder) readers of his paper. One thing can be said, the matter is always eminently practical and thoroughly reliable and this new recruit fits easily into the ranks. The 61 pages contain a large amount of useful information on hardening and tempering, as well as sections on case-hardening and on the forging of lathe tools, and as there are 39 good, clear diagrams and illustrations, the book is sure to appeal to the practical mechanic and user of tool steel. As such, it will interest many of our readers and we recommend them to get it.

"GENERAL REVIEW OF THE CONDITIONS AND PROSPECTS OF BRITISH TRADE IN INDIA DURING THE FISCAL YEARS 1919-20 AND 1920-21." (H.M. Stationery Office. 5s. 5d., post free.) This review, which is revised to October last, is of particular interest to the Engineering Industry, if only for the fact that it contains a full account of the position in regard to the purchase of Indian Government supplies and the detailed proposals for the new Indian Stores Department. There has been a growing feeling for many years among all sections of Indian opinion and particularly among Indian industrialists that the Government should adopt a more liberal policy for the purchase of such articles as can be manufactured in the country. Under this influence, the Stores Rules were modified in 1909 and 1913, but the greatest effect came as a result of war conditions. The latest figures reveal that the Indian Government's purchases of Indian produce and manufactures increased by 11.4 per cent. over the pre-war period, while the imports of stores from the India Office and London Boards of Indian Railways declined by no less than 20.6 per cent., and that with unrestricted rights of purchase there was an increase of 9.2 per cent. in the local purchase, through merchants and others, of imported stores. Under the Amended Stores Rules drawn up by the Government of India (they are not yet in final form), however, plant and machinery may be purchased from branches established in India of British manufacturing firms borne on the list of the India Stores Department, London. Thus, the many British engineering firms who have maintained branches in India for years, staffed with qualified engineers and commercial men and who, although remarkably successful in the industrial field, have hitherto been handicapped in quoting for Government orders under the old Stores Rules, seem likely at last to come into their own.

Besides statistical records, there are many other sections of special interest in this Review, such as the development of the hydro-electric power resources of India. The Trade Commissioner states in the latter connection that the position of United Kingdom firms is changed for the better since the Preliminary Report of the Hydro-electric Survey, published in 1919, recorded that British manufacturers of pipes, turbines, generators and switchgear were content to take small orders only, leaving the large ones to countries specialising in water-power plant.

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THE FRENCH POLISHER'S HANDBOOK. By "A Practical Man." (Percival Marshall. 2s. net).—Electricians are accustomed to associate a first-class polish with the cabinet work, cases and testing instruments forming or containing the apparatus used in the technical laboratories in their student days, and there is no doubt that such instruments fully deserve the care which is lavished on them by the actual manufacturers who believe that a good interior is worthy of a good exterior. Even the ordinary electric bell is more attractive if the wood case has a good polish; and the book before us tells very clearly how to get it, the tools to use, the materials to buy and how to mix them, what polishes are best suited to the work required (including the polishing of coffins) and altogether supplies a fund of valuable information which is calculated to make a member of the French Polishers' Trade Union denounce it in very strong terms for divulging "trade secrets." A well written section on gilding and bronzing adds much to the value of the book.

Various Items.

Books for Christmas.—If you want a good interesting technical book as a Christmas present to yourself, write to P. Marshall & Co., 66e, Farringdon Street, London, E.C.4, and ask for a copy of their latest catalogue. Also look at their advertisement in this issue.

Northampton Polytechnic Institute.—The Annual Prize Distribution and Students' Conversazione will be held on Friday, the 2nd December, 1921. The Right Honourable Lord Southwark, P.C., will distribute the prizes and certificates, and the proceedings will probably be of interest outside the walls of the Institute. The conversazione for members and students will be continued on Saturday, the 3rd December, when the building will be thrown open to the whole of the members and students and their friends.

E. D. A. Salesmanship Conferences.—The second of the series of Salesmanship Conferences, promoted by the British Elec. Devpt. Assocn. Inc., will take place at 8 p.m., Friday, Dec. 16, in the Chartered Institute of Patent Agents Building, at Staple Inn, Holborn. Mr. E. R. Morton (Sales Manager, Sun Elec. Co.) will speak on "Salesmanship in relation to Electric Power Driven Machinery in the Home." Mr. S. T. Allen will again occupy the chair. Particulars from the E.D.A. (84, Kingsway, W.C.2).

Direct Wireless to Australia.—A striking achievement in "wireless" was achieved recently, when test messages, prepared by an independent expert and transmitted in his presence, were sent direct to Australia from the Marconi station at Carnarvon. The apparatus used for this demonstration was a Marconi "valve" transmitter (said to be the most powerful of its kind in the world), each valve being about the size of a Rugby football. Cablegrams since received announce the reception of the messages, complete on the first transmission, both at Sydney and Melbourne.

About Transformers.—Preceding the publication of a comprehensive treatise on the whole subject of transformers, the old-established firm of Johnson & Phillips, Ltd. (Charlton, S.E.7), from whose works emanate amongst other equally famous products, transformers of all sizes and voltages and for all purposes, are issuing a series of "Transformer Abstracts." The first of these is now before us and we learn that the series is to be completed during the next three months by fortnightly issues. All transformer users should ask the Company to put them on their list of recipients, as the information cannot fail to be of direct interest.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 2nd inst., at Caxton Hall, at 8 p.m. Lecturette, "Notes on Maintenance of Electrical Accumulators," by B. L. Ladkin. Monday, 5th inst., at 2.30 p.m., visit to Messrs. Duroglass, Ltd., Walthamstow. Friday, 9th inst., at Royal United Service Institution, Whitehall, Presidential Address by C. H. Wordingham, C.B.E., M.Inst.C.E., at 7.30 p.m. Friday, 16th inst., at 8 p.m., Paper: "Notes on Searchlight Construction and Operation," by A. J. Simpson.——A Wireless Section Meeting of the Inst.E.E., in the Lecture Theatre of the Institution, on Wednesday, 7th inst., at 6 p.m., "An Investigation of Transmitting Aerial Resistances," by T. L. Eckersley, B.A., B.Sc.

Trade Notes.

The Dubilier Condenser Co., Ltd., of Ducon Works, Shepherd's Bush, London, W.12, is being wound up voluntarily for the purpose of Reconstruction. A new company is in process of formation to take over the old company as a going concern. The liquidation will not interfere with the company's business and all creditors will be paid in full.

Chain roller bearings, shaft couplings, W.I. split pulleys, friction clutches, etc., are dealt with in a (priced and dimensioned) booklet received from the **Vaughan Pulley Company** (West Gorton, Manchester).

British Insulated and Helsby Cables, Ltd. (Prescot, Lancs), have just issued a list, No. H 92, dealing with the jointing materials (tapes, Nubian paint, Chatterton compound, soldering paste, etc.), manufactured at their Helsby factory.

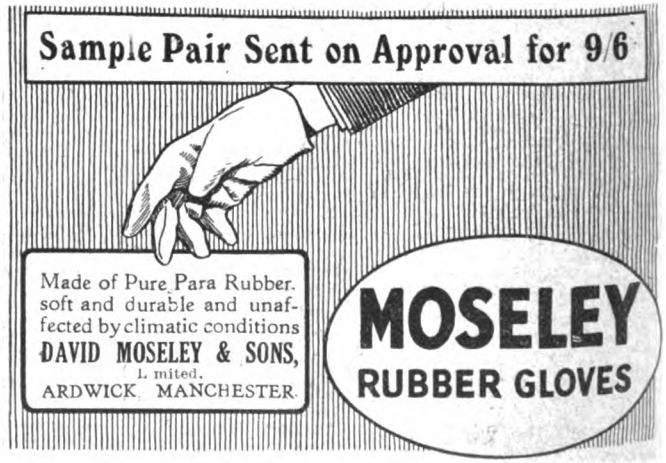
We have received from the **General Electric Co., Ltd.**, a copy of the booklet, "Electric Lighting in Factories and Workshops," by Gaster & Dow, one of Pitman's "Good Lighting" series. We understand that copies of the G.E.C. issue can be obtained *gratis* on application to Magnet House, Kingsway, W.C.2, or to any of the Company's provincial branches.

Kenrick and Jefferson, Ltd. (Head Office and Factory, West Bromwich; 22, St. Andrew Street, E.C.4, etc.), have issued the third number of "K. and J. News." It is devoted to the subject of business efficiency and deals with all office requisites. In a separate cover are many examples of K. and J. business stationery of all kinds, all of which are excellent examples of distinctive work.

To further the sales of Plexsim electric fires, particularly the Plexsim 600-watt projector fire, **Simplex Conduits, Ltd.** (Garrison Lane, Birmingham), have produced a new list (No. 903), in which we notice that the ingenious component parts of the projector fire are well illustrated and described, the complete article being handsome in appearance and convenient in use. The Company is further issuing a limited number of three-colour showcards of artistic design. Besides these aids, resellers will have the benefit of an extensive advertising programme.

The General Electric Co., Ltd., announce several interesting additions to their range of low and medium tension switchgear. Particulars of these new lines are given in a leaflet, No. X.2656, just issued as an addenda sheet to Section X and Y of their catalogue. This sheet, together with another leaflet, No. X.2651, giving revised catalogue prices of all items in this catalogue, is being mailed to the trade. Any of the Company's friends who desire to bring their copy of the catalogue up-to-date can obtain copies of the leaflets upon application to Magnet House, or any of the provincial branches.

An attractive leaflet from **Venner Time Switches, Ltd.** (45, Horseferry Road, Westminster, S.W.1), illustrates the well-known Venner time switches, at the same time pointing out their great value for automatically switching off shop window illumination at a pre-determined time after closing. There is no doubt of the advertising value of well-lighted windows and of the desirability of keeping them lighted, whether the shop be open or not, while prospective purchasers are about. Venner time switches are made to switch on and off automatically (14 or 45 day clock, 375 to 1,250 watts or 2,500 to 6,250 watts), or on by hand and off automatically (1 day clock, 1,250 or 2,500 watts).



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
DECEMBER 9, 1921.

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ELECTRICITY IN THE PUBLIC SERVICES.

The final meetings of the Public Works Conference, which has been held at the Agricultural Hall, Islington, during the whole period of the Exhibition, *viz.*, from November 18 to 25, were organised by the Incorporated Municipal Electrical Association.

At the morning meeting, which was presided over by Bailie Smith, of Glasgow, a paper was read by Mr. F. Ayton, Chairman of the Electric Vehicle Committee of Great Britain, on the use of electric vehicles for municipal purposes. Mr. Ayton will be remembered as the late engineer and manager of the Ipswich Corpn. electricity and tramways undertakings, and it was whilst holding that position that he became an enthusiast in the cause of the electric vehicle. He is now associated with the manufacture of them, and is with Messrs. Ransomes, Sims and Jeffries, of Ipswich. Vast strides have been made in the use of electric vehicles since the Electric Vehicle Committee was formed, and the figures given in Mr. Ayton's paper are eloquent evidence of this. There is no need speaking to the electrical industry to extol the virtues of electric vehicles; that has to be done to those non-electrical people whom it is hoped will become buyers. At the same time, it is often necessary to drive home to municipal depts. other than the electrical—although it must be confessed that there are some elecrical depts. that are not yet fully alive to the possibilities and advantages as will be shown—how beneficial it is all round for electric vehicles to be used for the work for which they are peculiarly fitted. There is no question of ousting petrol vans; the aim is to oust the horse, certainly, but also to give to the electric vehicle that work which it can do very much cheaper than any other form of transport. Thus it is that the other departments of municipalities can assist enormously, because there is much work done by them to which electric vehicles can be successfully and economically applied.

From the figures in the paper it was shown that there are now 413 electric vehicles in municipal service, mostly engaged in house refuse collection, and the experience from all parts of the country is just that of completely satisfactory service. So far as the discussion went, there was really only one dissentient voice, and that came from Westminster where there are apparently a few sceptics. The Westminster City Council has been carrying out a test between an electric vehicle and a petrol van for house refuse collection and it is agreed that the figures obtained show an advantage, per ton collected, of something like 2s. in favour of the petrol vehicle. But the circumstances in Westminster are not those of most other London boroughs, at any rate. Usually there is house to house collection and frequent stops, which tells in favour of the electric, but in Westminster the stops are not frequent. Moreover, Westminster is in the favourable position of being able to buy non-trust petrol at a very low figure. There are, however, complaints, if they may be called such, in other directions. Charging facilities and prices call for much work to be done yet. Current is usually charged at the motor-generator and by the time it is put into the battery it costs a good deal more than the 1d., 1½d. or even 2½d. which latter is charged to the user at Islington, because the losses in the motor-generator have to be taken into account. Then there seems no disposition in many places—and they are far too many—to provide charging facilities, and we seem to be running round the circle. In effect, the possible user says he will not buy until the charging facilities are there, and the supply stations say they will supply the facilities when the vehicles are there. So there you are. Hence the need for continued activity on the part of the Electric Vehicle Committee.

One other point: the price of the vehicles. Mr. Ayton holds out no hopes of a reduction in the immediate future. He says that manufacturers are taking orders now at cost or even less, and until trade revives and the demand improves, reductions in price are out of the question. We all understand the manufacturers' difficulties in these days, but we should have thought Mr. Ayton, with his reputation on the business side of the industry, would have held out some hope that manufacturers will endeavour to stimulate a demand for the vehicles by price reductions, rather than to adopt the old-fashioned British policy, which has so often been found not to pay, of waiting for a big demand before thinking of attracting the user on price. However, perhaps Mr. Ayton did not want to commit himself too much. Anyway, he expressed the pious hope, which has been heard so often during recent years, that prices will fall, and we could hardly, perhaps, expect more. No one can deny that the electric vehicle is making headway and doing good service and it is not likely that the manufacturers will pursue a false policy having regard to the competition they are up against from other forms of transport.

The other paper read at the Conference, on the 25th November, was by Mr. S. J. Watson, chief electrical engineer at Bury. It was largely of a statistical nature and gave the results of inquiries which have been made among 198 local authorities as to the use which is being made of electricity in their various depts. Streets, public buildings, schools, housing schemes, sewerage works, waterworks, gasworks; all were dealt with, and perhaps the most interesting item of the lot was the fact that even company gas managers are going to municipal electricity works for power for driving their machines, rather than generate their own electricity by means of gas engines and their own gas. Housing schemes, too, provided some interesting comments both in the paper and discussion, and one admires Mr. Watson's courage in installing electricity for lighting and gas for cooking. In these columns, not long ago, we suggested that that was a compromise which was the most satisfactory at the moment, although the local housing Commissioner took some convincing that electricity and gas could work together even in a domestic house. He thought that either one or the other should be adopted throughout, but he was convinced in the end.

ELECTRIC VEHICLE HANDBOOK. By Cushing and Smith. The only work of its class on the market. Limp leather. 8vo, 388 pp., 180 illustrations, 10s. 6d. post free from Rentell, 36, Maiden Lane, London, W.C.2.

Personal.—We understand that arrangements have now been concluded whereby Mr. L. M. Waterhouse, M.I.E.E., A.M.I.C.E., resigns his Directorship and retires from the Board of Messrs. Tube Investments, Limited., Simplex Conduits, Limited, and Credenda Conduits Co., Limited, manufacturers of Electrical Conduits and Fittings, Art Fittings and Signs, and Electrical Heating and Cooking Apparata. Mr. Waterhouse is starting in business at 19, Rathbone Place, W., and is specialising in the sale of Electric Heating and Cooking Apparata generally, which will include the well-known "Creda" make, and Art Fittings and Signs of Simplex manufacture.

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PROGRESS IN ILLUMINATING ENGINEERING.

At the opening meeting of the Illuminating Engineering Society, on November 15, Mr. L. Gaster, as usual, gave a review of progress during the vacation, reference being made to the First Technical Session of the International Commission on Illumination in July. The interest now taken in illumination by Govt. Depts. has been illustrated by the issue of several official reports, notably of the Departmental (H.O.) Committee on Lighting in Factories and Workshops, the M.o.H. Committee on the Effect on Eyesight of Lights used in Kinema Studios, and the M.o.T. Committee on Lights on Vehicles (motor-car headlights). Mr. Gaster also referred to a recent paper by Mr. D. R. Wilson, before the Royal Society of Arts on the subject of Industrial Fatigue, in which attention was drawn to the importance of adequate lighting.

Following Mr. Gaster's survey, a brief Report was presented by the Committee of the Society on "Progress in Electric Lamps and Lighting Appliances." From this it would appear that various difficulties lately experienced are being overcome and that satisfactory progress in the production of lamps and reflectors is being made. In this connection it may be noted that Mr. G. Campbell, in the course of the subsequent proceedings, showed some new types of "R.L.M." reflectors for industrial lighting, the contour of which has been designed with special care in order to diminish danger of glare.

As is usual at the opening meeting of the session, the rest of the evening was devoted to a series of exhibits illustrating progress in illumination and varied applications of light. Mr. Armstrong exhibited and described the Grubb headlight, the interesting feature of which is the control of the beam of light below a determined horizontal plane so as to reduce dazzle to a minimum, and another new form of headlight was also shown by Mr. W. J. Jones.

Mr. Haydn T. Harrison showed a new form of photometer of very simple pattern. In this instrument the small lamp is placed at one end of a box, into which a sheet of opal glass is recessed. The part of the glass nearest to the lamp is most brightly illuminated and we have a gradual diminution in brightness as we proceed away from the lamp. This gradation is indicated by a scale reading in foot-candles. The reading is obtained by moving across the instrument a strip of white paper surrounding a small "grease spot." The white paper receives the illumination to be measured. The grease-spot receives light by transmission from the opal glass underneath. Accordingly, there is one particular position, corresponding to a certain reading in foot-candles, where photometric balance is obtained. A feature of the instrument is the ease with which it can be read by a number of observers simultaneously.

Developments in artificial daylight formed the next subject. Mr. Groom showed a number of the latest models of the Sheringham Daylight, mentioning several important recent improvements. Amongst these are the use of a new ultramarine pigment of higher reflecting power and the introduction of a small area of yellow on the coloured surface in order to improve the quality of the light. By these means the efficiency of the lighting unit has been approximately doubled—naturally an important point in the case of artificial daylight apparatus, where the absorption of light is necessarily great.

The other method of producing artificial daylight, by transmission of light from a tungsten lamp through a disc of special blue glass, was dealt with by Mr. F. E. Lamplough, who showed a cabinet containing a lamp fitted with Chance's glass, an ordinary gasfilled lamp, and a form of spurious "artificial daylight," obtained by using an unsatisfactory variety of glass. The interesting feature of this spurious artificial daylight was that it resembled daylight very closely in appearance but was nevertheless very unsuitable for colour-matching. This Mr. Lamplough demonstrated by placing selected dye fabrics under the three lights in turn.

A highly interesting demonstration was given by Mr. W. J. Jones of the use of ultra-violet light in testing precious stones. Under the intense ultra-violet light of a tungsten arc, screened by special glass, the gems fluoresce. The interesting thing is that, by a knowledge of the fluorescence which a certain variety of gem should show, one can readily detect "shams"; more than this, one can even distinguish genuine stones from different localities. Mr. Jones also showed that by this method Oriental pearls can be easily distinguished from those of the Japanese variety.

Other exhibits included some of the new small neon lamps, now being used for letter-signs and night-lights, which consume only 5 watts and can be inserted into an ordinary lamp-holder on a 200-volt supply. Mr. Ruthven Murray showed some pleasing examples of his "internalite" signs adapted to colour changes, and Mr. Ancotts exhibited a new form of sign involving patterns or letters outlined in small mirror-discs which have the power of focussing surrounding rays and becoming bright points of light even in relatively dark surroundings.

The demonstrations were witnessed by a large audience and aroused much interest.

INDUSTRIAL FATIGUE.

A most interesting survey of the work of the Industrial Fatigue Research Board was given in a lecture delivered by M. D. R. Wilson before the Royal Society of Arts, on November 9. While for a considerable number of years attention has been devoted to the health and safety of those engaged in factories, the physiological and psychological response of the worker to his work have been almost entirely neglected. With this the Board has been largely concerned.

The problem is not an easy one. Industrial fatigue may reveal itself in various ways, amongst the factors to be studied being variation in output, sickness and mortality, labour turnover, lost time, accidents. Naturally, such factors vary widely in different industrial processes. Those that are largely automatic, for instance, may not show the effects recognised in operations that are tiring and require constant attention on the part of the worker.

The effect of hours of labour, which was studied in detail by the Health of Munition Workers Committee, is of special interest. Variations in output throughout the week also yield useful information. Curves presented by Mr. Wilson showed well-marked cycles of efficiency throughout the working day; in some cases there is also a progressive change throughout the week, cumulative fatigue being clearly indicated, with a corresponding recuperation as a result of the rest on Sunday. Another feature is the seasonal variation of output in certain trades, due to alterations in conditions of temperature, humidity, etc., which may affect power of working. The effects of lighting on production have also been studied, an investigation of the silk weaving industry leading to the conclusion that the output under artificial light is in general 10 per cent. less than by daylight.

It is quite evident that researches of this character are of considerable value, both to the nation and to the industries concerned. The field of work is a large one, but unfortunately little real expansion can be expected so long as its study is left entirely in the hands of a central body with limited funds, whose activities have been recently curtailed owing to the need of national economy. The most hopeful prospect in the immediate future is for individual industries to co-operate with the Board in extending the work, which is in their own interest.

Personal.—Mr. J. S. Child who recently resigned his position as Joint Sales Manager to the Edison Swan Electric Co., Ltd., has opened temporary offices at 185, Wardour Street, London, W. 1 (telephone number: Regent 6167; telegraphic address: "Jayesscee, Ox, London"), and will be glad to be favoured with manufacturers' catalogues.

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KINEMATOGRAPHY AS AN INDUSTRY.

There is an industrial opportunity of considerable magnitude awaiting those British manufacturers who first realise that kinematography has passed the period of probation and is firmly established as part of our national life. In general terms this statement has, of course, been an accepted fact for years past, but in the immediate future there will be a development of the film industry in this country which will far exceed any progress already accomplished. The thousands of kinema theatres in the country have permanently assured audiences, critical to a degree and demanding first-class productions, which are changed at least once and generally twice a week. The aggregate demand for films amounts to an almost incredible total and involves the provision and use of a correspondingly large amount of "producing" equipment.

As exhibited, the film shows only the players and a comparatively small scene, so that it is not commonly realised what a wealth of equipment and labour goes to make up this apparently simple result. Quite apart from the theatre buildings with their electric generating plant or motor-generators, etc., their projectors and arc lamps, and their steady demand for general supplies and replacements, there is the producing side of the industry. Whilst it is true that one good film may circulate amongst thousands of theatres, it forms only a fraction of the programme and that for only a few days, so that tremendous activity is required in the studios to keep pace with the demand.

STUDIO CONSTRUCTION AND EQUIPMENT.

Many more studios have yet to be built and their construction and equipment represents a large amount of potential business. The daylight studio is a steel-framed building with walls and roof almost entirely of glass. In this country it is generally necessary to supplement daylight by artificial lighting for photography indoors, and in many studios artificial lighting is employed exclusively. To produce the lighting required by kinematography demands the use of batteries of high-power lamps, the energy and material supplies to which represent heavy annual expenditure. The private generating plant, or motor-generators if electrical supply be taken from public mains, together with the switchboards for controlling studio lighting, constitute an installation more important than the electrical equipment of many a works or factory. In addition, the lorries provided by all modern producers for use on outdoor work are often fitted with electrical plant for lighting night scenes. In the aggregate the supply and maintenance of all this equipment represents an industrial opportunity.

Innumerable fittings of all descriptions are required in a kinematograph studio making any claim to efficiency. Workshops are required for the construction of special scenery and hitherto practically all scenery has been built "on the spot." There seems to be a good field, however, for manufacturers to specialise in the construction of scenery for kinematograph studios. Standardised components are required capable of being assembled to suit various sizes of scene and lengths of "shot." The actual scenes themselves must, of course, be varied—to a greater extent, indeed, than in the past, for regular patrons of the "movies" already recognise certain familiar interiors—but there is room for further standardisation and improvement in scenery regarded as an engineering structure and in its bracing and fittings. The use of special fabrics for scenery, costume and screens is a means whereby considerable improvement in photography and projection may be attained.

Models are now used much less extensively than in the past in the production of films, but they are indispensable for special purposes, such as certain explosion scenes, etc. Hitherto models have generally been home-made affairs, but the photographic excellence of present-day films is such that any but the best models appear as what they are and evoke derisive applause! Where models must be used, they must be true to scale, perfect in detail, and excellently finished—in short, they should be made by expert model makers, and not by amateurs. This opens up another field for manufacturers—smaller, but still profitable.

Apart from the enormous quantities of film and chemical supplies required by the photographic department of a studio, the dark rooms need heating and ventilating equipment, and so do the studios themselves.

THE WIDENING FIELD OF APPLICATION.

Turning from the question of supplies to that of application—which naturally reacts upon the former—the uses of kinematography are ever extending. Not only is there a steady increase in the number of large and small kinematograph theatres used solely for purposes of entertainment, but there is also a steady increase in the utilitarian applications of the art. Photographs taken at high speed and projected at much lower speed offer the only means of analysing at leisure rapid motions such as those occurring in the flight of birds or the operation of machinery. For this reason kinematography offers a valuable means of conducting scientific research and of effecting reliable "motion study." To the salesman of machinery it offers a means more effective than any number of still photographs or any amount of verbal explanation, and for general educational purposes it offers obvious advantages offset by only one disadvantage—the inflammability of celluloid film. There is every reason to believe that non-inflammable films will soon be on the market, in which case the already rapid progress of kinematography will be further accelerated, to the benefit of this and all associated industries.

HYDRO-ELECTRIC POWER.

At the I.E.E. informal meeting, held on Nov. 21st, Mr. J. F. Avila was in the chair during the discussion opened by Mr. A. J. Hainsworth on "Hydro-Electric Power." The meeting was very well attended and thoroughly successful. Mr. Hainsworth commenced by saying: "My remarks will be mainly based upon current practice in New Zealand, where I have resided for about fourteen years. It is essential that any power-station should at the outset be designed for the ultimate capacity of the available water power, and so arranged that the full development may be carried out in stages. There is nothing to hinder this being done in water-power stations, as the total power available can be determined at the start. If it be decided to develop the station by stages as the demand for power increases, it would be good practice to commence laying out the general plans at the centre, and assume that the building will extend longitudinally in both directions. A station layout is often spoiled for all time by having the switchboard placed across one end so that, as the station develops, the distance betwen the switchboard operator and the floor engineer becomes greater as the units increase in number.

The hydraulic features of any scheme must necessarily fix both the locality and site of the building. The location is often remote from civilisation, and the roads incapable of carrying the heavy machinery and apparatus to the site. These are the features which control the size of the generator and transformer units to be used, which I consider should be as large as possible, always keeping in mind the limitations imposed by shipping facilities, railway tunnels, etc."

Mr. Hainsworth then proceeded to describe a typical station, saying: "It is not intended to describe the dam, forebay pipe-lines and hydraulic equipment, but it may be of interest to state that the head of water on the turbines is approximately 170 ft. Each turbine has its own supply pipe, separate in-take chamber, head-gate and screen. There are twelve supply pipe-lines, each 9 ft. in dia., and one smaller pipe for the exciter units. The overhead inlet pipes to the turbines are so arranged to get a direct flow with the minimum number of bends. The turbines are of

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the Francis type, with double wheel discharging into a single curved draught tube. The water supply to each turbine is controlled by main valves arranged for either hand or motor control. This typical power-station was designed for a maximum plant capacity of 144,000 h.p. in twelve 12,000 h.p. 11,000 volt, 3-phase, 50 cycle generating units, two 230 volt, 470 h.p. water-driven exciter sets, two motor-driven exciter sets of similar size and eight 15,000 k.v.a. step-up, 11,000 to 110,000 volt transformer banks."

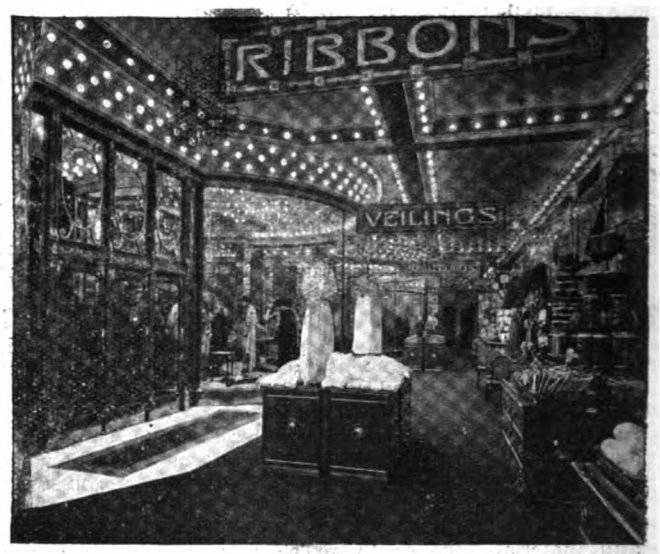
Proceeding to fuller details, Mr. Hainsworth dealt with the importance of every consideration for the ventilation of the generators, the oil piping layout for the transformers and switch tanks, the spacing of conductors, etc., for all of which no hard and fast rules can be laid down. He then described a transmission system projected by Mr. E. Parry for the New Zealand Govt. for a network of 1,000 miles of 110,000 volt transmission lines in North Island, and next, an existing 66,000 volt system in South Island, from Lake Coleridge, which has been in service since 1914.

Capt. J. Coxon opened a well-maintained discussion of which, perhaps, the most striking feature was the ubiquity of the engineer; first-hand knowledge of many water-power systems being contributed. Professor P. M. Baker spoke of the unique system of rain-water stored for power-generation in the Bombay Presidency, where, despite the long periods between rainfall, supply is made to the cotton mills at .55 anna per unit. Mr. D. F. Campbell described systems in North Carolina and on the Pitt River, in California. Mr. M. R. Gardner told of the single source of electric power and lighting to Rio de Janeiro, and Mr. W. M. B. Macdonald of the hydro-electric system of the St. Lawrence River. Mr. A. N. Aikman, R. S. Allen, P. S. Fox, Dr. R. D. Gifford, Major R. Grierson, J. R. Harding, E. F. Hetherington, A. G. Hilling, L. M. Jockel, R. L. Narayanan, E. M. Pearson, W. E. Rogers, G. J. D. Scott, G. E. Taylor and E. L. Webb also spoke, after which the points raised were replied to by Mr. Hainsworth.

NOVEL STORE LIGHTING.

In a store, the proprietors of which pride themselves in always exhibiting the newest and most artistic dresses from Paris, it is only to be expected that the decorations and lighting effects should be of an elaborate and novel nature. That this is so in the instance of the Galeries Lafayette, recently opened in Regent Street, will be evident from the accompanying illustrations. Previous attempts to use bare incandescent lamps in such huge quantities and at such close spacing have been productive of results which can only be described as garish, but in the present instance a very fine effect has been obtained by the use of a large number of frosted bulbs sunk in elaborate plaster mouldings. The lamps, therefore, not only serve to provide light, but also form an integral part of the decorative scheme. The lamps for this purpose had to be of special and exact dimensions to fit into the holes left in the plaster mouldings. In order that the effect should not be spoiled by uneven brilliance of lamps burning only 18 in. apart, each lamp had to be specially selected and tested, so that all were of even brilliance.





Over 15,000 220-volt, 20-watt Osram lamps, 125 mm. overall and 70 mm. dia., and 1,000 40-watt Osram lamps, 145 mm. overall and 80 mm. dia., were used in connection with this scheme.

We are indebted to Messrs. F. Sage and Company, Ltd., who were responsible for the installation work, for the photographs reproduced herewith.

A MODIFIED LECLANCHE CELL.

The junction of the manganese dioxide in the ordinary form of Leclanché cell is to oppose polarisation by absorbing the hydrogen liberated by the action of the battery. During the war there was a great scarcity of manganese dioxide in France, and Féry therefore devised a cell of the Leclanché type which did not require manganese dioxide. According to *La Nature*, the cell employs a cylindrical block of porous carbon which rests on a thin perforated sheet of insulating material below which is a zinc disc forming the other electrode of the cell. The superficial layers of the liquid absorb oxygen from the air so that, when hydrogen is formed on the face of the carbon nearest the zinc by the ordinary electrolytic action of the cell, there is established an auxiliary gas cell between the upper face of the carbon (which is in liquid rich in oxygen and therefore of positive polarity) and the lower face which is coated with hydrogen. In the circuit of this auxiliary gas cell, oxygen is liberated at the lower face of the carbon and combines with the hydrogen there present, whilst hydrogen is formed on the upper surface and there combines with the oxygen in the electrolyte. It is claimed that the carbon is thus kept free from polarisation. Other claims for the cell are that the ammonia salt is regenerated within the cell and that the zinc is not attacked whilst the cell is on open circuit.

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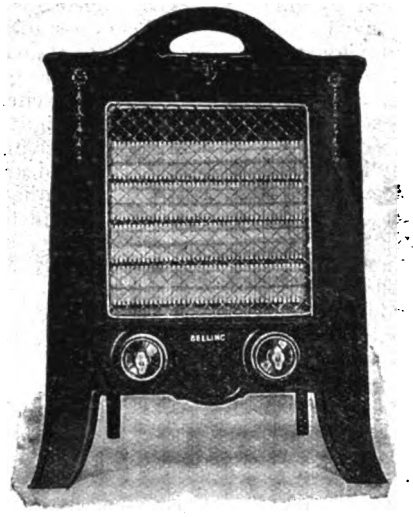
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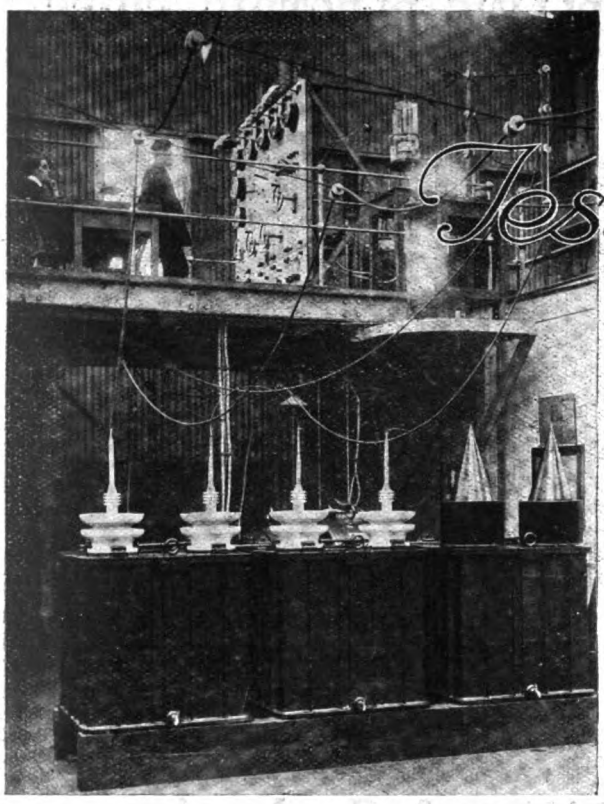
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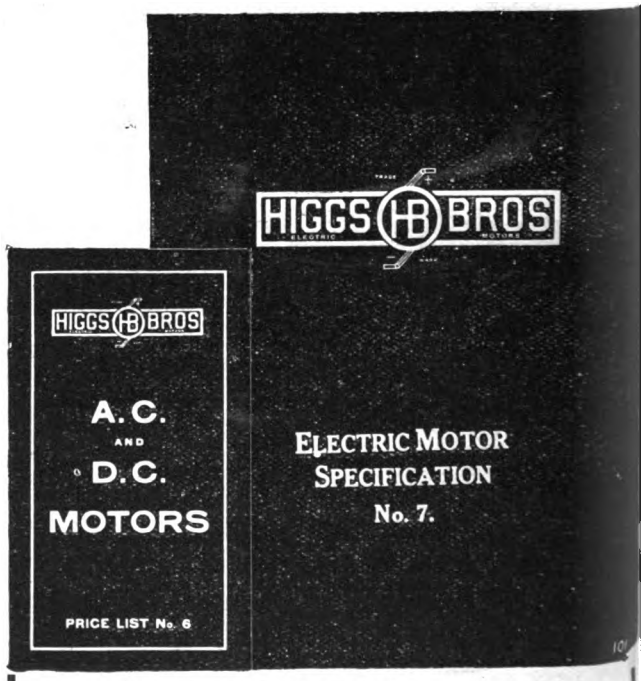
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

There was a rather interesting and prophetic leader in the *Daily News* recently, following which a correspondent predicts the ultimate downfall of this country as an industrial area. According to this correspondent the increasing cost of all fuels must bring water power for producing electrical energy into its own. Industrial and commercial activities will thus be transferred to countries like Canada and the United States. The British Isles, he thinks, would then become largely residential, as is already the case in the home counties and southern coastal England. As this mentor points out, vast industrial populations are quite a modern phenomenon, dependent upon cheap coal and extensive markets abroad for commodities the various countries cannot themselves produce.

Will Industry Migrate?

Although, perhaps, rather too far-seeing a theory to hold water so far as this generation is concerned, there is ample precedent for the suggestions conveyed. Even in this country there are numerous examples of the gradual growth of an industry, its era of prosperity and subsequent decline through causes brought about by the efflux of time and changed conditions. To give one little known example: I visited some years ago an old-world village on the shores of the Firth of Forth, a place once famous for its local industry, the making of "griddles" (I am not sure whether I have the correct spelling), the wrought-iron implements for the fashioning of the famous Scotch cakes. This industry flourished before the modern foundry developed, with its possibilities in the matter of fashioning iron implements by the casting process.

In due course cast iron succeeded wrought for many purposes, among others the making of "griddles," and the small village industry declined and eventually disappeared altogether. One could cite scores of similar examples where individual crafts peculiar to certain areas or districts of the British Isles have gradually passed from the era of prosperity into the historical records of the country of origin. With these facts in mind, and a full appreciation of our growing industrial difficulties, it is not impossible to visualise our children's children reverting to agriculture or other means of livelihood, whilst the more venturesome emigrate to industrial centres far removed from the present Midlands or Black Country where, when all is said and done, cheap coal has, in the past, automatically determined the industrial area of Great Britain.

It is interesting to note the periodical revival of old-established electrical principles to fulfil modern requirements, and, in this connection, the Hughes' induction balance, familiar to every student of electricity and magnetism, has played its part in many practical applications during recent years. During the war considerable use was made of this device for locating shells buried in the ground or hidden beneath ruined buildings. It was also pressed into service by the hospital surgeons for locating shell splinters, bullets, etc., in the bodies of the wounded, whilst enterprising inventors endeavoured to press it into service also for the location of submarines.

An Old Friend in a New Guise.

If my interpretation is correct, the latest application is to the guidance of fog-bound aeroplanes. To this end a cable is suspended along the route followed by a regular aeroplane service, at a short distance above the ground, and is kept charged with an alternating current of such a frequency as to be readily audible in the telephone receivers which constitute part of the aeroplane equipment for location. The plane itself carries two coils, one of which is fixed vertically, the other horizontally. Whilst flying over the route indicated by the cable, the two coils are affected inductively, in varying degrees, according to their mutual distance from the cable. The horizontal coil is the more sensitive when the plane is immediately above the cable, but, with increasing distance, the relative effects upon the two coils more nearly approximate, and, with experience, an aviator can roughly gauge his distance and position in relation to the guiding cable beneath. The invention hails from France, where a series of exhaustive tests have been made with great success.

The urgent need for reliable comparisons between the relative costs of electric, petrol and horse vehicles for municipal requirements was emphasised at the recent conferences of the I.M.E.A., where several speakers testified to the claims of the electric in the matter of direct saving over horsed vehicles, but sponsors for the electric- as compared with the petrol-driven vehicle were not so prompt in support. Champion of the municipal or "heavy" electric vehicle, Mr. F. Ayton, chairman of the Electric Vehicle Committee of Great Britain, who has done so much to popularise these vehicles for public service, pointed out that the type had an assured "life" of ten years or more, whilst its electrical energy was generated from a staple fuel-coal; whereas the petrol vehicle depended upon imported liquid fuel, which was unstable in cost and of which a world shortage was possible in the not very distant future.

Electric Vehicles.

Mr. Priestly, of Sheffield, describing his Corporation as one of the largest users in the country of electrics for municipal services, testified that the cost of removing house refuse worked out at 9s. 8d. per ton employing electric vehicles, as against 10s. 6d.

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when making use of horse cartage. Mr. Wyatt, of Grimsby, also spoke in favour of the electric service by comparison with horses, and claimed a saving of 1s. 10d. per ton of refuse collected. These statements were, however, somewhat discounted by Mr. F. W. Cable, who stated that experiments under his observation had shown an advantage of 3½d. per ton in favour of petrol-driven vehicles as compared with electrics. These statistics are on a par with many others which have appeared from time to time in the columns of contemporaries devoted to municipal interests, and it seems to me that the time is ripe for the sponsors of the municipal electric vehicle to institute a series of trials somewhat on the lines of the Liverpool heavy motor trials of twenty years ago, which were so ably organised by Mr. Shrapnell Smith, and so materially assisted in establishing the heavy commercial motor vehicle in its present position for goods transport.

The electric vehicle is already accepted in the States as a prominent auxiliary of the petrol-propelled type, and its possibilities only require to be sufficiently impressed upon municipal officials and others in this country for it to enjoy an equal vogue. For comparisons to be equitable all the conditions must be similar or as nearly equal as is possible to make them. The fundamental principles of the two types of vehicle are so dissimilar, and the conditions which influence their running costs so variable, that only carefully prearranged and observed trials can determine which type is best for a given service. If Mr. Ayton has the ear of the electric vehicle trade, and the influence to bring it about, I strongly counsel the effective organisation of such a series of trials as I have indicated.

Electricity and Precious Stones.

The opening meeting of the Illuminating Engineering Society is coming to be regarded as *the* occasion on which novel lighting devices or applications of light are to be seen, and the gathering on November 15th proved no exception in this respect. The Hon. Sec. contrived to pack in a great variety of demonstrations within the 1½ hours allotted—photometry, motor headlights, artificial daylight, neon lamps and luminous signs all being exhibited in turn. One of the most interesting items was doubtless the revelation of the value of ultra-violet light in testing precious stones, particularly in distinguishing the genuine gem from imitations. Ultra-violet light, apparently, can reveal what the human eye unaided can scarcely detect. This case of the illuminating engineer coming to the assistance of the dealer in jewels strikes us as a remarkable illustration of the wide-roving range of the Society.

ELEKTRON.

Electrification of South African Railways.—The D. O. T. is informed that the South African Rlys. and Harbours Board have now definitely decided on the electrification of 171 miles of railway from Glencoe to Pietermaritzburg.

Meetings.—The 17th Ann. Gen. Meeting of the Birmingham and District Electric Club will be held at the Grand Hotel, on Sat., the 10th inst., at 7.0 p.m.——The next meeting of the I. E. E., Scottish Centre, will be held in The Rooms, 207, Bath Street, Glasgow, on Tues., 13th inst., at 7.30 p.m., when a Paper, with illustrations, by Messrs. L. J. Steel and H. Martin, on "The Cyc-Arc Process of Automatic Electric Welding," will be discussed

TELEPHONE LINE WORK IN THE UNITED STATES.

By E. S. BYNG.

The Paper read recently before the I.E.E., by Mr. E. S. Byng, gave interesting and important details of telephone line work in the U.S. It dealt with staff organisation, development studies, design and lay-out of plant, engineering and constructional methods (pole routes, aerial cables, conduit routes, underground cables, house cabling, block cabling and wiring, drop wiring), transport, mechanical and labour-saving devices, and maintenance. We are reprinting it practically in full. The author points out that the U.S. now contains about 70 per cent. of the telephones of the world, and the engineers concerned have therefore enjoyed a better opportunity of developing and improving their plant methods than has been afforded elsewhere. Their work has been carried on in comparatively new cities which were growing rapidly, and among people who regarded the telephone not as a luxury but as a necessity of business and social life. The field, moreover, was left open to commercial enterprise. Telephone development in America was thus stimulated to a degree to which no other country affords a parallel.

STAFF ORGANISATION.

In order that the evolution of telephone practice in America may be understood, the organisation in force will be briefly indicated. The American Telephone and Telegraph Company (the A.T. & T. Co.) and its associated and connecting companies, constituting what is commonly known as the Bell System, control approximately 12,600,000 telephone stations. In addition, there are about 900,000 stations owned by independent companies, not connected in any way with the Bell System, but competing directly with it in certain territories. The entire country is covered by these associated companies.

Each company has its local organisation, the operating side being generally divided into 4 major divisions, *i.e.*, (1) Engineering, (2) Plant, (3) Traffic, (4) Commercial. The chief officer of each department is directly responsible to a vice-president or general manager of the company. The author then deals with the organisation in some detail and gives also the allocation of the work among the departments.

The responsibilities of the Plant, Traffic and Commercial Depts. are necessarily distributed over the territory of each company, and the staffs are correspondingly located. The Eng. Dept., however, has a general head-quarters staff and is so placed in the organisation that all projects for addition to the plant must receive the chief engineer's approval before being acted on by the Executive Committee. In the last analysis no small measure of direct responsibility rests with the chief engineer in the matter of producing a fair return.

Each associated company furnishes the exchange telephone service for the cities, towns, and villages situated within the territory over which it operates; it also provides a local trunk service between one place and another within the same territory. Systems of long-distance trunks between towns in different territories are furnished by the Long Lines Dept. of the A.T. & T. Co. Although it forms a part of the main company, this department is managed practically as a separate company and has its own organisation covering the whole of the country.

The A.T. & T. Co. constitutes the central controlling organisation for the whole of the Bell System. The technical side of the head-quarters staff consists of two main departments, the Dept. of Development and Research, and the Dept. of Operation and Eng., each under the charge of a vice-president of the company. These departments act in an advisory and consultative capacity for the associated companies, and it is due to this organisation that a standardised telephone system has been established throughout the U.S.

In addition to the Technical Department of the central

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organisation, the engineering staff of another of the associated companies in the Bell System, the Western Electric Company, is called upon to develop new devices and to carry out all laboratory investigations and tests. The Western Electric Company is responsible for the manufacture of all telephone apparatus and cable for the Bell System; it also acts as purchasing agent for all auxiliary supplies conforming to specifications prepared by the A.T. & T. Co.

Development Studies.

A forecast of the development for many years ahead is necessary in order to secure an efficient telephone system. This forecast forms the basis for a number of important phases of planning and engineering, such as the lay-out of exchange areas, current-rate treatments, fundamental plant and equipment plans, and provisional estimates and budgets.

On the basis of a comprehensive study of all local characteristics by the Commercial Eng. Dept., a map is prepared showing the estimated development for each "working" section during the planning period decided upon for the town concerned. For a fast-growing territory a 15-year figure is taken; under normal conditions, however, the period is 20 years. Intermediate figures for 6-year and 12-year periods are also given, as these facilitate the preparation of the fundamental plan. (Note: Fuller information is given in the Paper.)

Design and Lay-out of Plant.

The fundamental plan is intended to give the situation of the exchanges and conduit routes, both existing and proposed. The new conduit routes are laid out so as to give the most direct path from the exchange to any block, following a definite plan of distribution. The disposition of the existing plant, being a controlling factor in many instances, is also taken into consideration. The fundamental plan does not attempt any refinement of detail; it is a rough conjecture of the probable telephone requirements. The proposed main routes are indicated, but the actual installation is not begun until it is required by growth, street improvements, or local regulations. In other words, the fundamental plan serves as a general guide to the plant engineers, so that, when a plant extension has to be made, it may be of the proper size and correctly arranged.

Fundamental plans are usually reviewed every five years, so that, as far as possible, a comprehensive, consistent, and economical system of distribution is secured. In general, an underground conduit system is adopted in all main thoroughfares and business streets; in the outskirts of a city, and for distribution work, aerial cables are used extensively. The limiting lengths of the various sizes of copper wire, which are dependent upon transmission requirements, are determined for the exchange area as a whole.

The block-building system lends itself very conveniently to a symmetrical lay-out of plant, the plant engineer taking a block as a unit for telephone distribution. The dimensions of a block are generally 600 ft. long by 400 ft. wide. In the business sections, where a large number of circuits are required, a block is divided into several sections, each of which is served by direct "house" cables. Where the telephone density is not so great, block-wiring—either external or internal—is adopted. In "thin" areas it may be economical to arrange the distribution from short poles erected either in the alleys within the block or in the roadway between adjacent blocks.

Reference has been made to the use of aerial cables. Ever since the days of overloaded open-wire routes the advantages of the aerial cable as an economical means of providing telephone service under certain conditions have been realised. On the other hand, aerial cable was at one time considered to be a transition stage between open-wire and underground construction. Owing to ring cuts, crystallisation of the lead sheath which occurs at poles, and other defects which were frequently the cause of breakdowns, it was deemed advisable in many cases to place important long-distance cables underground in order to ensure continuity of service. As a result of close investigation the defects mentioned were gradually eliminated in the case of subscribers' cables, and the success thus obtained caused the engineers to turn their attention to long-distance cables, with the result that it is now the settled policy, where local conditions permit, to run all long-distance cables aerially. (The advantages and disadvantages of aerial cable, as compared with underground cable, are discussed later.)

Subscribers' cables are referred to as either main or distribution. The term "main cable" is considered to mean the large sizes of cable radiating from an exchange, into which the distributing cables are jointed. The distribution cable is the branch cable which feeds the actual distribution points. The standard sizes of No. 22 B. & S. gauge cable (10 lb.) range from 25 to 900 pairs, plus 1 per cent. for defects. If a greater number of pairs is required in a 2¼-inch diameter of lead sheath—known as "full-size" cable—No. 24 B. & S. gauge (6½ lb.) conductor is used. With these conditions a 1 200-pair cable can be obtained. The latter cables are used in fast-growing areas and in the main runs of larger cities where transmission requires permit. Experiments are now being conducted in order to ascertain if it is possible to manufacture and use a No. 27 B. & S. gauge cable (3½ lb.) in large telephone cables planned for 1 500 pairs.

In all subscribers' cables a colour code is adopted. For main cables the distinctive coloured pairs are arranged in groups of 100, plus 1 per cent., so as to facilitate testing and numbering through. For a 1 200-pair cable the colour code for the paper insulation is as follows:—

Group.	No. of Pairs.	Colour of Wires.
1	100	Red-White
	1	Red-Orange.
2	101	Blue-White
3	101	Orange-White
4	101	Green-White
5	101	Red-Blue
6	101	Red-Green
7	101	Red-White
8	101	Blue-White
9	101	Orange-White
10	101	Green-White
11	101	Red-Blue
12	100	Red-Green
	1	Red-Orange

The paper wrapping is applied to the wires in a spiral and therefore no cotton binding is required to hold it in place. Two wires are twisted together to form a pair, and the pairs are stranded in layers. In "quadded" cable, the two pairs forming a "quad" are each served with a cotton binding, but there is no serving over the "quad."

Some years ago, in America, it was considered that lead alone did not possess the mechanical properties essential for a satisfactory cable sheath. The requirements were that the sheath should be capable of enduring a reasonable amount of abrasion, of bending without kinking, and also of resisting chemical action. It was found that an alloy of 97 per cent. lead and 3 per cent. tin had the requisite mechanical strength, even when the thickness of the sheath was reduced. Owing to the increasing price of tin, experiments were made with other alloys, resulting in the final adoption of an alloy of 99 per cent. lead and 1 per cent. antimony for cable sheaths of both overhead and underground telephone cables. Before the cable is sheathed a layer of red paper is placed over the complete core for the purpose of enabling workmen to separate scrapped sheath, so that antimony-alloy sheath and tin-alloy sheath may not become mixed. It also serves as an indication to jointers that the sheath contains antimony.

In planning the cable lay-out in the centre of a large city it is not usual to consider diminishing or tapering main cables. The objection to opening main cables for the purpose of transferring branch cables to afford relief, or for connecting new branches, has been removed by the provision of large stubs.

(To be continued.)

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NORTHAMPTON POLYTECHNIC: PRIZE DISTRIBUTION.

Last Friday, at the Northampton Polytechnic Institute, the prizes and certificates gained during the year were presented to the successful students by Mr. Arthur Barton Kent. Over seven hundred students had gained certificates of one kind or another, besides which four took the degree of B.Sc. and twenty-six that of B.Sc. Intermediate at London University. Mr. L. B. Sebastian presided.

The Principal, Dr. R. Mullineux Walmsley, read his report. He stated that there had been a record session; the enrolments and the quantity of work done in the educational department being far in excess of those in any pre-war year. The enrolment of individual members had reached the large total of 3,802. In the Engineering Day College the number had risen from 252 in the preceding year to 295 in October, 1920. This further increase in the total number was due to a continuance of the influx of ex-Service men sent to the College with substantial maintenance grants to enable them to train for re-entry into civil life; but even when these, who numbered 157, were deducted, there remained a substantial number of students, largely in excess of any number attending in pre-war times. But a sufficient interval had not elapsed for the first line of the wave of ex-Servicemen to reach the final year, so that the number of students who had been able to complete the four years' course was few. Only fifteen certificates were awarded to students in full-time day courses. For the current session all sections of the whole-time course were now filled. Normal work in the second and third year courses had been seriously interrupted by the coal stoppage. Over 120 students should have been placed out in works early in April, but the negotiations for obtaining vacancies had been interrupted, and could not be resumed until July; and, consequently, only about half the men had been placed out.

Of evening work, Dr. Walmsley reported that the large enrolments of the preceding session, which had been double those of the session preceding it, had been more than maintained, there being a total of 6,259 class entries by 2,625 individual students. The number of individual enrolments and total number of hours worked were far in excess of the similar figures for 1904-5—the record year of pre-war times—but the average hours per student had not yet reached the pre-war standard.

Other matters mentioned in the report included the statement that ten certificates had been awarded by the St. John Ambulance Association, and the number of members of clubs and societies connected with the Institute had risen from 1,031 to 1,242.

Mr. Arthur Barton Kent delivered a short address before making the presentations. Among other things he said that, in view of its importance, enough was not being done for technical education by the State. The influence of the Northampton Institute was wide; it had old students as far away as New Zealand.

Besides the distribution of prizes and certificates, there were organ recitals in the course of the evening, and all the laboratories, workshops, etc., were thrown open to the large crowd of visitors. Displays were given in the gymnasium and swimming bath.

STABILITY IN THE COST OF LIVING IN VIEW.

Very interesting predictions have been made month by month as to the fluctuation in the cost of living by Mr. H. G. Williams, M.Sc., in the *Industrial League and Council Journal*, and it is gratifying to note in the current issue of that publication that Mr. Williams foresees in the very near future the coming of stability of prices. The plea has consistently been made by responsible exponents of thought in the world of labour that if stability in the cost of living can be secured many of the present causes of discontent will automatically right themselves, because of the fact that the great mass of workers, particularly those whose earnings are regulated by sliding scale agreements, will know they are assured of a definite income. It will be interesting to watch developments. Some months have elapsed since Mr. Williams expressed the opinion that stability of prices would be reached between March and April of next year, by which time the cost of living would drop to about 75 per cent. above the pre-war level. In many of his assertions he has been exceedingly prophetic of actualities, and while he does not recapitulate himself, he continues to infer the issue he has regularly maintained. "The course of wholesale prices, as a whole, is still downward," he says, "but in the case of some commodities rock bottom has been reached, and a slight rise has occurred. Last month I suggested that retail prices would probably become stable about 70 to 80 per cent. above the pre-war level, so that the index number will probably drop another 30 or 40 points with corresponding effect on wages in all those trades which have sliding scale agreements.

"Furthermore, whatever may be the views of organised employers or organised workmen in the other trades, corresponding readjustments in wage rates are inevitable.

"From the point of view of steady employment and consequent prosperity, the best thing that can happen is that the changes in prices and in incomes shall take place with the greatest rapidity, as a full flow of trade will be impeded so long as the future of prices and of the cost of production is uncertain."

Mr. Williams is lecturing at Caxton Hall, Westminster, on Wednesday, the 14th inst., at 7.30 p.m.

AN INVESTIGATION OF TRANSMITTING AERIAL RESISTANCES.

A paper on the above was read by Mr. T. L. Eckersley before the I.E.E. Wireless Section on December 7. The paper describes an attempt which has been made to reduce to a minimum the energy losses in the neighbourhood of such aerials, which are known to be very inefficient. It is shown that favourable results are obtained by interposing a screen of wires between the aerial and earth, and using this screen as a counterpoise earth instead of using the usual buried earth. The losses in such a system are analysed, and it is shown that a large fraction of the earth losses are eliminated when such a screen is used. Formulæ are devised for predetermining the resistance of screened aerials, in terms of the conductivity of the earth and the surface dielectric loss. Such aerials have the drawback that the wires of the screen itself may form an oscillating system, and under certain conditions oscillations are set up in this system which waste energy. Methods of dealing with and eliminating these losses are discussed. Finally, the method of screening is compared with Alexanderson's multiple-earth system, and it is concluded that a combination of the two methods should give the best results.

Screens have been employed successfully at large power stations, for example, at Clifden, and it now requires only one-sixth of the power to produce signals at Glace Bay equal to those formerly produced by the spark station. It is evident, therefore, that the practice of long-distance wireless telegraphy may be very considerably modified by these results.

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Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

Question No. 130.

Recently, I had cause to test two new 200 volt, 6 h.p., direct current motors. These are shunt machines, two poles, but the windings round the poles are connected in parallel. The rated speed is 1,400 r.p.m. On test the speed is 1,420 r.p.m. at full load, and 1,300 r.p.m. at no load. If, at no load, the rocker is moved to bring the speed up to 1,400 r.p.m., when the load is placed on the machine the machines race away as though the field was broken. Can any reader tell me why this should be, and what the remedy is?.—"TESTER."

(*Replies to Question No. 130 must be received not later than December 10, 1921.*)

ALL AMERICA.

The cable steamer *All America*, which has been built and engined at the Neptune Works of Messrs. Swan, Hunter and Wigham Richardson, Ltd., to the order of the All America Cables, Incorporated, went to sea on Tuesday, October 11, for her trial trip, and kept up a speed of 13¼ knots. The vessel, which is almost a duplicate of the cable steamer *Guardian*, also built at the Neptune Works in 1907 for the Central and South American Telegraph Co., is a twin-screw cable-repairing steamer, about 295 ft. in length overall, with a length between perpendiculars of 270 ft., a breadth of 37 ft., and a depth moulded of 24 ft. 9 in. She has been built under special survey to Class 100 A1 with Lloyd's Register of Shipping, and is also arranged to conform to the American shipping requirements.

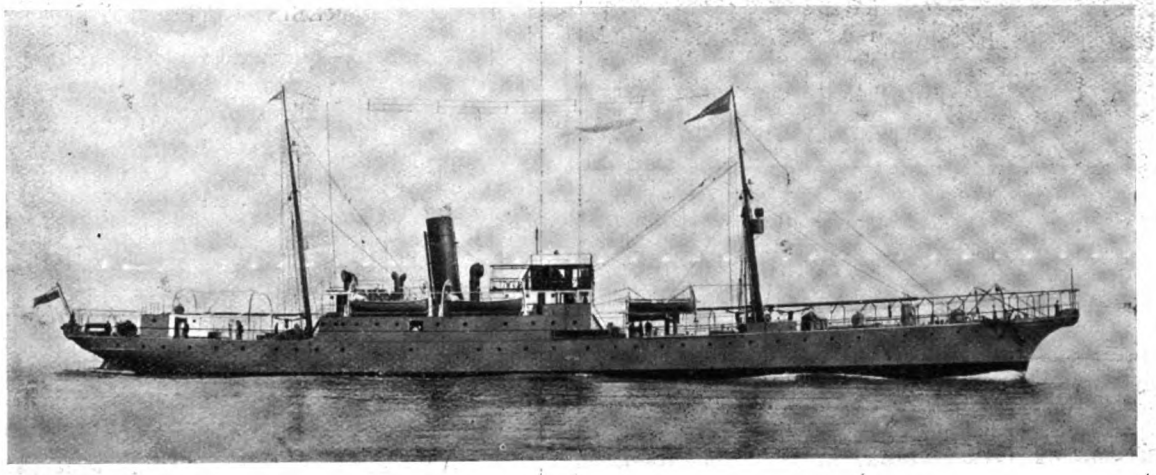
The vessel has four cable tanks, three forward and one aft. All these tanks have steel cones, and the two largest cable tanks have inner tanks. There is a total coiling capacity in the cable tanks of about 14,000 cubic feet. The cable machinery, which is being supplied by the Telegraph Construction and Maintenance Co., of London and Greenwich, is of their latest and most improved pattern. There are three bow sheaves forward and one aft, and the necessary deck leads, dynamometers, telegraphs, and other accessories required in vessels for cable-laying.

The accommodation for the telegraph and cable staff is very complete, being arranged on the upper and awning decks amidships. There is a large testing room and battery room on the awning deck, and there are workshops and suitable arrangements for storing the buoys and special appliances used in cable-repairing work.

The accommodation for the captain, ship's officers, engineers and crew is of a superior type. Amidships there is a roomy and handsome dining saloon in polished oak. The captain has commodious quarters in a house on the boat deck. The officers' and engineers' rooms are arranged amidships, and the crew are berthed aft.

The propelling machinery consists of twin-screw triple-expansion engines of the builders' own design and make. The diameters of the cylinders are 15½ in., 25 in. and 43 in. respectively, with a stroke of 30 in. Steam is supplied by two boilers 13 ft. 3 in. in diameter by 11 ft. 6 in. long, designed for a working pressure of 180 lb., and fitted with Howden's forced draught. The boilers are arranged to burn oil fuel. For this purpose there are oil fuel bunkers of large capacity, enabling the vessel to keep at sea for a long period without having to return to port to replenish her fuel.

The auxiliary machinery includes electric light and power plant, of which there are two sets, one steam



THE TWIN-SCREW CABLE-REPAIRING STEAMER, "ALL AMERICA."

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driven and one oil driven; refrigerating machinery and insulated chambers for the ship's provisions; a Lucas sounding machine, two steam winches, a steam windlass, steam steering gear, and an installation of wireless telegraphy for a day range of 200 miles. The vessel's equipment includes a motor life-boat, two steel life-boats, and other working boats suitable for the vessel's service.

During the trial trip the owners were represented by Mr. A. Scott Younger, of Messrs. A. R. Brown McFarlane and Co., Ltd., who has acted as consultant on behalf of the owners, and Captain Taylor, under whose command the vessel will begin her career. We are indebted to our contemporary, *The Shipbuilder*, for the loan of the illustration.

A LARGE LIFTING MAGNET IN A STEEL WORKS.

There has recently been installed, in an important British steel works, what is believed to be the largest lifting magnet yet constructed—it is certainly the largest made in this country. It is 66 in. in diameter, weighs 58 cwt., is capable of raising a maximum load of 15 tons, and was constructed by the Witton-Kramer Electric Tool and Hoist Works, at their Witton Works, near Birmingham.

Forming part of an installation for handling and breaking up scrap metal and delivering it to the charging box for furnace filling, the complete equipment takes the form of a 25-ton overhead crane which spans the road on which the metal is received, the scrap yard, and the road on which the charging boxes are assembled.

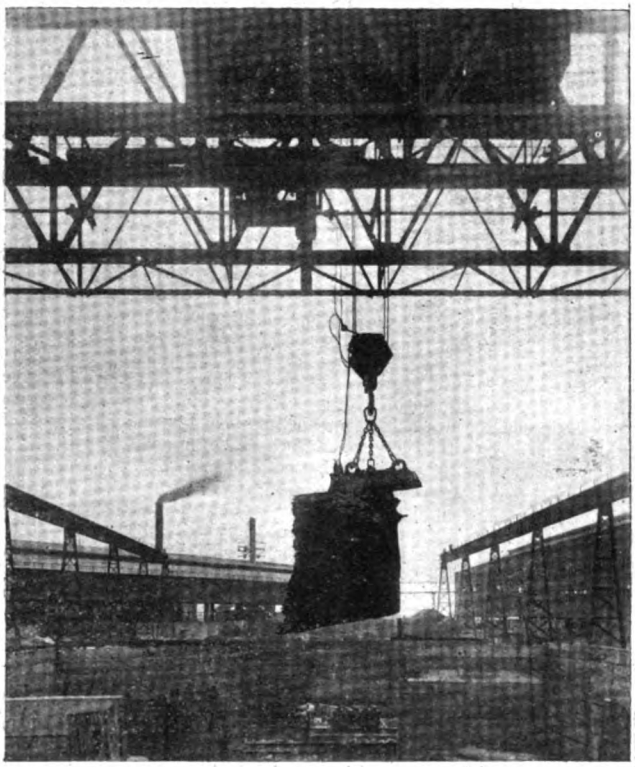


FIG. 1.

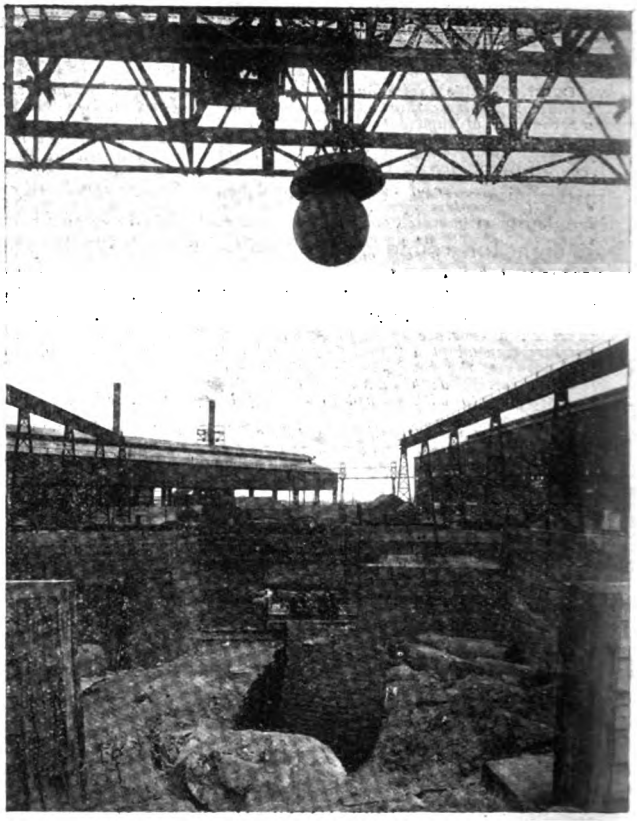


FIG. 2.

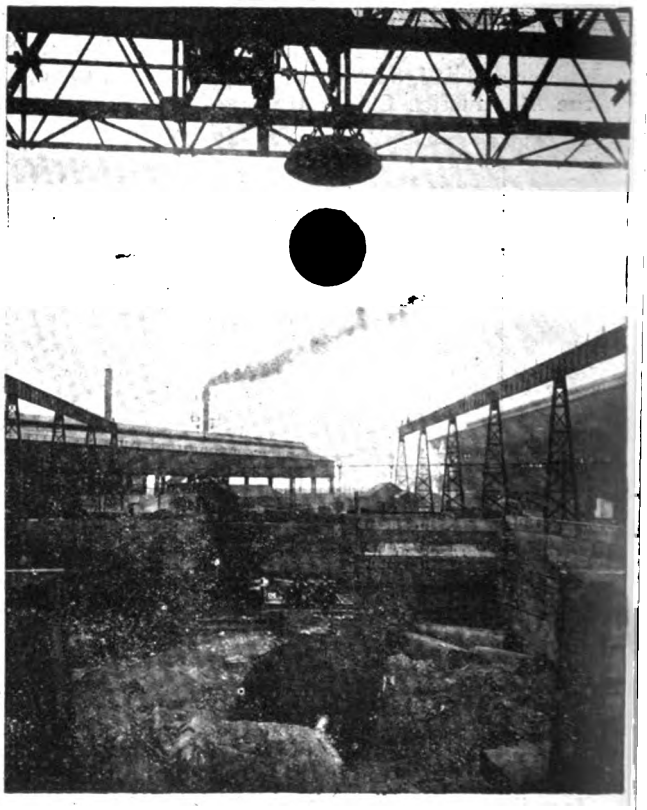


FIG. 3.

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The magnet is first used to unload the scrap (Fig. 1). This consists largely of "skulls"—the linings of the steel ladle—composed chiefly of slag, not of great weight but of thin section, bulky dimensions and extremely poor magnetic quality, containing but little metal, and therefore requiring a large magnet area to lift. The scrap is then placed into stock by the magnet and delivered by the same means from stock to the breaking pit. The "skulls" are broken by means of an eight-ton round cracker ball. No centering device



FIG. 4.

is necessary, and the magnet lifts the load on practically a point contact. After the scrap is broken up the metal is removed by the magnet (Fig. 4) and fed to the charging boxes.

All these operations can be controlled and carried out rapidly and economically by the crane driver, with the sole exception that, when filling the boxes, a ground man is required to rake into position the metal which is delivered in bulk over the row of boxes.

MODEL GENERAL CONDITIONS FOR CONTRACTS.

The work of revising the I.E.E. Model General Conditions for Contracts, which began in April, 1920, was completed at the end of last session and a new edition was published on November 1, 1921. In addition to the members of the Committee of Revision nominated by the I.E.E., there was included a number of representatives of other Associations within, or closely connected with, the electrical industry, and through these representatives the Committee had the benefit of the views of the governing bodies of the various Assocns. interested in the Model General Conditions for Contracts.

The new Conditions have been issued in such a form that they be used as the actual contract by filling in the blank spaces.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]*

THE MOTOR BOOK. 268 pp. (St. Jame's Press. 5s.)—This is, we believe, the first complete, compact and convenient book of reference to be published in which one can quickly turn up the number of cylinders, h.p. and seating capacity of the various makes of cars on the market, and the name and address of the nearest agents for any make of motor vehicle, so that repairs can be put in hand or advice sought from a firm which specialises in that particular make. Being sub-divided, the reference is rendered very easy and we would add that we have found much of the information extremely useful. In passing, we must mention that motor cycles are also dealt with, as are component parts. A further section, devoted to a list of "reputable garages" in the principal towns of the country should appeal to long distance travellers by road, to whom also the "where to go and what to see" section may be of interest. Finally, there is a considerable amount of miscellaneous information which has been well chosen, and presented in a form which can be digested readily by busy people without waste of time. By making the accessories manufacturers' sections fuller, the publication should become one of great value.

ELECTRICAL WONDERS OF THE WORLD. By F. A. Talbot. (Cassell, fortnightly parts, 1s. per part.)—The story of electricity in the service of man is as stirring as any romance that has ever been written. In "Electrical Wonders of the World," a new serial publication which is being published by the House of Cassell in 24 fortnightly parts, at 1s. each, net, the whole field of electricity in science and industry is told in fascinating language, and illustrated with hundreds of magnificent pictures in colours and black and white. It will, therefore, make as strong an appeal to the general reader as to those who are already familiar with electricity, either as a hobby or as a science. Part 1 is now on sale and opens with a remarkably interesting description of the wonderful feats which are now performed by the great electric lifting magnets in use in steel works, rolling mills, etc. It is beautifully illustrated and makes most absorbing reading. The next chapter deals with hydro-electric stations, and describes some of the monster plants in California. Altogether this new serial is likely to catch on with the reading public.

Trade Notes.

The receipt of the December issue of the "Monthly Magazine" of **Higgs Bros.** (Sandpits, Birmingham) reminds us that Christmas will soon be here. It has a joyous touch about it, and is quite as interesting to the busy engineer as some of the special publications now available at bookstalls—with this difference, it does not have to be paid for The dynamo and motor stock list included shows that, as usual, the Coy. has a wide range of machines in stock or progress. These machines are not given away, like the magazine, but the modest fees asked in exchange make them excellent value, as they are efficient and trouble-free. Don't wait for the January bargain sales. Settle your requirements now.

A large number of artistic silk shades of up-to-date design is illustrated and priced in List No. S.S. 242, just issued by the **Edison Swan Electric Co., Ltd.** (Ponders End, Middx.). Included are floor standard shades, wood table standards and shades, indirect dish shades, pendant shades, silk shades for table standards, silk shades for electric candles, cardboard and billiard shades, accessories, etc.—altogether an excellent selection.

We are informed by **The Westminster Tool and Electric Co.** (Westool Works, Putney, S.W.15), that they are now in a position to supply their well-known Westool electric portable drills in sizes up to 7/8th inch holes, fitted with universal motors, rendering them suitable for use either on direct or single phase alternating current circuits. They report excellent results with these new tools.

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Various Items.

S. E. Lancs. Electy. Dist.—The local Inquiry is to be held on the 17th prox., at the Town Hall, Manchester.

Dividend.—The Marconi International Marine Communication Co. announce an interim dividend of 5 per cent., less income tax.

Morwell Electric Power Scheme (Australia).—Tenders have been accepted as follows:—Power-house building, Redpath Brown and Coy. (£114,750); boilers, John Thompson, of Wolverhampton (£280,000).

The Limit.—We have received a copy of the latest issue of "The Limit"—the live magazine of the Loughborough College (Leicestershire). All concerned in its publication have reason to be proud of their efforts, and no doubt it is much appreciated by the 800 or 900 students in training at the College.

Artificial Heating.—A most instructive and exhaustive lecture on "Artificial Heating in relation to Human Needs" is to be delivered by Mr. J. W. Beauchamp, before the Nat. Assocn. of Supervising Electricians, at St. Bride's Inst., Ludgate Circus, E.C. 4, at 6.45 p.m., on Tuesday, the 13th inst.

Smoking Concert.—At the Grosvenor Restaurant, Gordon Street, Glasgow, on Sat., 17th inst., at 7 p.m., the I.E.E. (Scottish Centre) will hold a Smoking Concert; tickets, 2s each, can be obtained from Mr. W. L. Winning, 166, St. Vincent Street, Mr. Neil M'Killop, Corporation Electricity Dept., 75, Waterloo Street, or Members of Committee.

A New Society.—The time for the formation of a society composed of all interested in welding has probably now arrived, and we understand, an inaugural meeting, at which the proposal can be considered and the formation of a society undertaken, is to be called at an early date. Particulars from Mr. C. Raggett of the "Acetylene and Welding Journal" (30, Red Lion Square, Holborn, W.C. 1).

University College, Nottingham.—The wide syllabus of day and evening classes is clearly set forth in the Calendar for the Session 1921–2, and those contemplating entering on a course of study there, as well as those at present in training, should make a point of carefully studying its pages, as University College, Nottingham, is among those up-to-date institutions where the needs of all classes engaged in engineering and technology are carefully studied.

Mumbles and Electricity.—Mumbles, which has been made famous by the bravery of the women of Mumbles Head when launching the lifeboat many years ago, will shortly have an installation laid down by the Borough of Swansea, which has lately absorbed that pretty seaside resort into its boundary. The borough electrical engineer estimates the cost at £15,000. They would want about 500 consumers. The engineer has been requested to prepare a report upon the matter.

Seasonal Window Display.—The G.E.C. have just completed in one of their windows at Magnet House, an excellent display which is attracting considerable attention from passers-by. Father Christmas is shown on a snow-clad roof putting "Magnet" heating and cooking devices down the chimney under the light of the moon and under the eyes of a black cat. By an ingenious construction the "Magnet" Appliances can be seen descending in a dim-red light.

Secondary Cells.—This is the title of an interesting and most useful paper on this subject which was read last year before the Inst. of P.O.E.E., by Mr. R. G. De Wardt, A.M.I.E.E., and has just been published in book form. It is clearly written and well illustrated, and as it is written mainly from the point of view of a postal telegraph engineer, it is sure to be of direct value to our numerous readers in that branch of the service. The price is 1s. 3d. net, post free, from Messrs. Rentell. Clients should also ask for a copy of the latest list of papers on sale dealing with items which appeal more particularly to telegraph and telephone engineers. It is well worth looking through.

"The Outline of Science."—Part 2 of this most interesting serial from the house of Newnes (fortnightly, 1s. 2d.) continues the chapter dealing with the story of evolution, explaining such items as the development of instinctive behaviour, animal intelligence, parental care, etc., all of which are illustrated with excellent plates. The next chapter treats on the procession of life through the ages, with a chart showing the rock record, after which other pages deal with the evolution of land animals. The continuation of the "Romance of the Heavens" section opens with an explanation of the Nebular Theory, and is followed by details of the great astronomical instruments which have been built in recent years. A very readable number.

The Batti-Wallahs.—Mr. W. E. Ireland presided at the smoker which was held at the Engineers' Club on Friday last, and the members and guests who were present, to the number of about 80, all expressed themselves as delighted with the entertainment provided by friend Greenly, who has worked so hard to make us happy in these times of dull trade and little money. Some well-known faces were missing, but the Kelvin Lodge was represented worthily by its two principal officers, as well as other members, while Messrs. Newton Russell, R. W. Hughman, Jack Avila, E. P. Bennett, "Uncle" Pooley and others all looked very cheerful. The next thing to prepare for is a big muster at the annual dinner, of which notice will be issued in due time.

Service Notes.—The Admiralty having come to the conclusion that the complicated character of electrical apparatus and torpedo equipment in the Fleet warrants the division of the electrical artificer branch of the Navy into two branches, an Order in Council just issued has sanctioned the institution of the two branches described in a schedule, with the pay and conditions of service of the existing electrical artificer branch, which they now supersede. The titles, under the new order, will be—electrical lieutenant and lordnance lieutenant (T), commissioned electrical officer and commissioned ordnance officer (T), warrant electrical officer and warrant ordnance officer (T), chief electrical artificer, chief torpedo artificer, and electrical artificer and electrical torpedo artificer.

Carmarthen.—Last Friday a serious fire occurred at the generating station belonging to the Carmarthen Electric Light Co., Ltd. The building, erected some 14 years ago, was situated behind the market, and the only part that was saved was the acid rooms. The outbreak was discovered about 1 a.m. and the fire brigade were quickly on the spot, but the fire, fed by large quantities of oil, soon made headway and the flames spread rapidly making a raging furnace. The explosion of two oil tanks made a deafening noise and woke nearly all the inhabitants. The damage is estimated at many thousand pounds. The old town of Carmarthen is in darkness and the position soon became serious as many residences, tradesmen's shops and practically all the chapels, churches and other public buildings had for their illumination supplies from the company.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 9th inst., Presidential Address by C. H. Wordingham, Esq., C.B.E., M.E.Inst.C.E., M.I.E.E., at Royal United Service Institution, Whitehall, at 7.30 p.m. Also on Friday, 16th inst., "Notes on Searchlight Construction and Operation," by A. J. Simpson (Member), at Caxton Hall, S.W.1, at 8 o'clock.—The I.E.E. will meet in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C.2, on Thursday 15th inst. at 6 p.m. Paper, "Induction-Type Synchronous Motors." By L. H. A. Carr (Member.)—At the next meeting of the Association of Engineers-in-Charge at St. Bride's Institute, Bride Lane, Fleet Street, E.C.4, a paper will be read on December 14, at 7.30 p.m., by Major W. Gregson, B.Sc. (Eng.), on "Utilisation of Exhaust Gases from Internal Combustion Engines."

Cattle Show.—At the Smithfield Club Show which has been held during the present week at the Agricultural Hall, Islington, there were as usual a very large number of exhibits of engines and tractors and other machinery directly suitable for farming and agricultural apparatus generally. Many of the engines were of the small type which can also be utilised for electric lighting, and such well-known firms as Blackstone, Petter, Robey, Ruston, Hornsby, Amanco, etc., were all doing their best to book orders. In addition there were numerous exhibits by firms who specialise in belting, oils and accessories for engineering use, including Messrs. W. H. Willcox & Co., Ltd., Hobdell, Way & Co., Ltd., etc. We can recommend electric lighting contractors to make a point of visiting this show each year; they are nearly certain to find something of engineering interest which might be of direct business value.

Gearing Combine.—Messrs. Bostock & Bramley, power transmission engineers of Netherton, Huddersfield, have now combined interests with Messrs. Joshua Buckton & Co., Ltd., of Leeds, for the manufacture of all types of gearing to their designs and specifications. This old established firm enjoys exceptional manufacturing facilities, together with a long experience in the production of high class gearing. Bostock and Bramley, on their side, possess an intimate knowledge and unique experience of the practical applications of gearing in all branches of mechanical engineering. Their internal arrangements are such that all overlapping is eliminated, the work being so arranged that the combination will enable them to produce the highest class of power transmission units on a sound commercial and economical basis consistent with the best quality of material and workmanship.

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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
DECEMBER 16, 1921.

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A NEW DEVELOPMENT IN MOTOR STARTING PANELS.

The satisfactory operation of motor-driven machines depends so greatly on the performance of the motor starter which is adopted, that improvements in starter design are received with general interest. Particularly will this be the case as regards the adaptation of the drum design for starter service—a development long contemplated but not hitherto brought to fruition.

Where, as in starter practice, resistances have only an intermittent rating, a most important feature of the design is naturally the provision of a safeguard against leaving the starter handle in an intermediate position where a portion of the resistance might be in circuit for long periods. In the faceplate design of starter, this safeguard takes the form of a spring controlled handle which, if released before reaching the "full-on," flies back to the "off" position. To this end, however, there must be no abnormal friction between the fixed and moving contacts, and this fact places a limit upon the possible contact efficiency with this design of starter.

While, therefore, the faceplate type has in general proved a reliable and satisfactory form of starter, much attention has been devoted to the possibility of adapting for starting duty the drum design so successfully employed for controller service. The drum construction secures a self-aligning contact under a considerable pressure on each step. Obviously, however, if it is to be employed for starting duty, there remains the problem of safeguarding the resistances against being in circuit for any length of time. It is the solution of this problem which is the most interesting feature of the new drum type starting panels manufactured by Messrs. Brook, Hirst and Co., Ltd., of Chester (Fig. 1). The crux of these designs is the patent operating handle which actuates the drum and which is of the ratchet type, thus ensuring "slow motion" operation. The required safeguard is obtained by a dual motion, which merits attention.

Before ratcheting, the handle must be raised vertically through an angle of 180 deg. This movement closes the "control switch," consisting of a copper disc and two fingers at the far end of the barrel. The electrically operated main switch is thereby energised and it is possible to commence starting the motor by ratcheting forward to the "full-on" position. If the handle be released before reaching "full-on," it falls (being spring controlled) to its normal position and, by opening the "control switch," breaks the main circuit. The electrically operated main switch cannot again be closed unless the starter barrel is ratcheted round to the "start" position. Normally, of course, the starting operation would be completed without interruption until, on reaching "full-on," a stop were encountered, when the handle would be released. The "control switch" would thus be opened, but the circuit would be maintained by an auxiliary drum contact. On again raising the handle, it would be found possible to make a *single forward movement* to "off" without any tedious ratcheting back through intermediate positions.

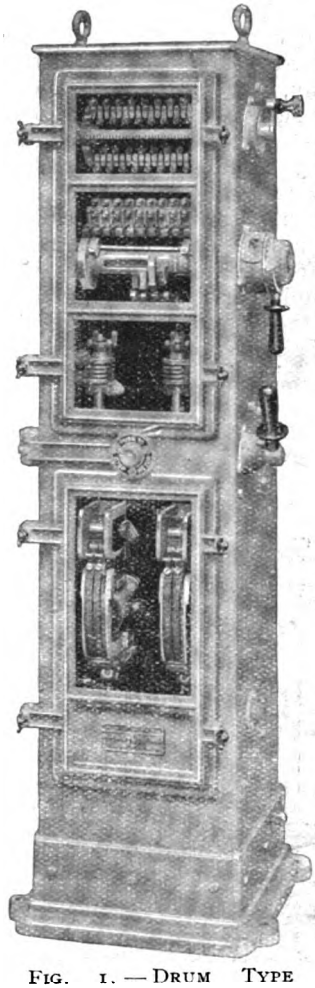


FIG. 1.—DRUM TYPE STARTING PANEL, FOR VARIABLE SPEED MOTORS.

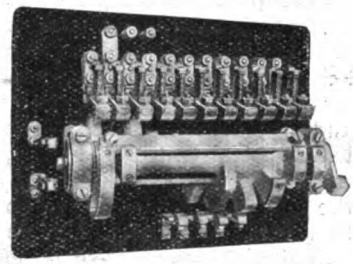


FIG. 2.—DRUM TYPE STARTER (WITHOUT OPERATING HANDLE), SHOWING CONTROL SWITCH.

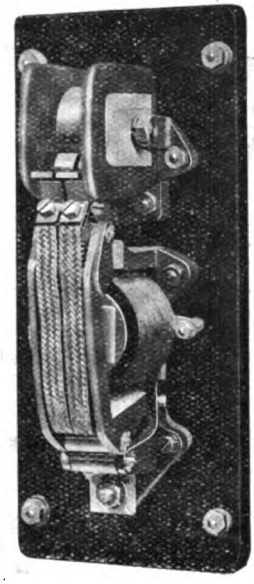


FIG. 3.—CONTACTOR.

Such are the principal features of the "Brookhirst" patent ratchet operating handle; it remains to describe briefly the Drum Type Starter which it has done so much to make possible. This is illustrated in Fig. 2, and embodies a drum and fingers of robust construction. The drum is ground with the copper segments in position so that the latter form part of a true cylinder and give clean and even contact with the fingers. These are spring-controlled and are thus self-aligning. An adjustable nut provides for main-

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taining a constant contact pressure throughout the life of the finger. The finger and drum contacts are never called upon to break the full current, this being always effected by the electrically operated main switch. These conditions, coupled with the "step-by-step" movement of the ratchet operating handle, ensure a long, useful life for both drum segments and finger contacts.

A panel such as that illustrated in Fig 1, comprises a drum type starter, shunt speed regulator, two electrically operated contactors, two overload trips, and double pole isolating switch. The shunt regulator needs little description, differing only from the standard arrangement in that it is screw-operated, the contacts being arranged, not circularly, but in two parallel straight lines. This secures "slow motion" operation and economy of space. The two contactors, one of which is illustrated in Fig. 3, constitute an electrically operated main switch, and by relieving the starter of the duty of breaking the main current, add greatly to the reliability of the apparatus. They also permit unlimited "inching" to be effected, merely by raising and lowering the starter handle or by pressing an "inch" button fixed near the operator. Several "stop" buttons can be fixed in convenient positions.

In conjuncton with two solenoid type overload trips, these contactors provide the equivalent of a true "free handle," double-pole circuit breaker, effective under overload, failure of supply, interruption of the starting operation or depression of the "stop" button. The overload trips are fitted one in each pole, the operation of either being sufficient to open both contactors. The trips are adjustable to operate at any desired percentage overload and are normally arranged to operate instantaneously. Alternatively they can be fitted with an oil dashpot as shown in Fig. 4, thus providing a time lag which may be adjusted to suit the conditions of individual applications.

The double pole isolating switch is a feature of considerable importance, permitting as it does the instant isolation of the motor, ironclad panel and remote controls. It is so interlocked with the doors that it provides complete safety for the operator. Between the glazed doors of the panel is fitted a locking bar illustrated in Fig. 5. The locking cam on the left of the panel, is mechanically coupled to the handle of the isolating switch, so that only when the switch is "off" can this cam be in a position to receive the projecting stop on the locking arm and allow it and the doors to be opened. When the isolating switch is "off," the supply side and main terminals are, of course, still "alive," but these parts are enclosed in an inner chamber, which may be locked and sealed. These interlocking arrangements cannot be evaded, short of their complete and permanent removal, so that it is practically impossible for the operator to come into contact with "live" parts.

Panels such as those described are suitable for motors up to, say, 100 h.p. at 200 volts. For larger motors or for heavy starting duty, the panel is generally similar, but comprises a Multiple Lever Starter, as shown in Fig. 6, thus completing the range of hand operated starting panels.



FIG. 4.—OVERLOAD TRIP WITH TIME LAG.

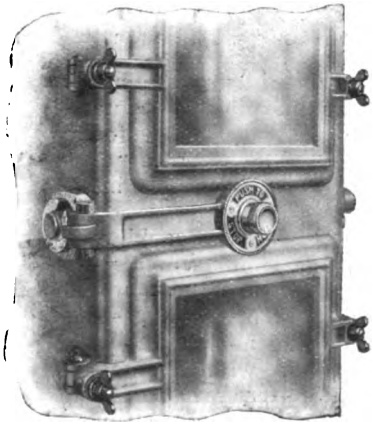


FIG. 5.— DOOR LOCKING BAR, INTERLOCKED WITH ISOLATING SWITCH.

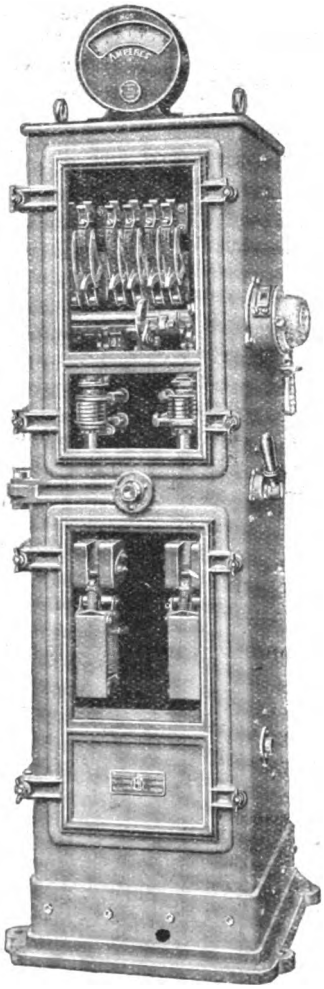


FIG. 6.—MULTIPLE LEVER TYPE STARTING PANEL, FOR CONSTANT SPEED MOTORS.

BATTERY LOCOMOTIVES.*

By JAMES DALZIEL.

Electric shunting locomotives may be either operated from overhead wires or from a self-contained battery. Certain limitations imposed by the battery roughly define the respective spheres. Generally speaking, battery operation is most suitable for yards where the work is moderate and fairly uniform, especially where fairly long lengths of infrequently worked siding are involved. In such cases battery locomotives will economically replace horse or capstan shunting. A probable field for battery traction on electrified main lines is that of working way-side sidings with a battery tender to supply the main line locomotive. Some branch lines may be worked economically with battery locomotives. Shunting in large goods yards will probably be best effected by locomotives combining overhead conductor with battery supply, the battery dealing with the lightly worked sidings. Where the obstruction of an overhead wire is objectionable, as on quay sides, battery operation is the only form of electric traction possible.

Supply by battery alters for the worse the operating characteristics of an electric locomotive, especially as regards overload capacity. Straight battery working is not suitable for heavily worked sidings, or those out of which an occasional heavy lift has to be made, and the same applies to lines having heavy gradients, or requiring at certain hours specially heavy trains to be handled.

* Abstract of Paper discussed at the Engineering Conference 1921 (Inst. of Civil Engineers).

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In such cases overhead conductors should be used; undue increase in battery capacity and weight, or the provision of special types prohibitively enhances cost. Mid-day boosting charges are adverse to the life of all batteries of whatever type.

Many existing sidings where locomotive operation may be contemplated are equipped with turntables. If it is, as it may be impossible to substitute points for these, a capstan may be fitted to the locomotive, so as to enable it to pass over such turntables and into the sidings they serve.

The dimensions, weight and capacity of locomotives naturally vary in accordance with the work to be performed. A locomotive built by the Midland Railway in 1913 to supersede horse shunting in a London coal yard, is as follows:—

Weight	17 tons 7 cwts.
Draw-bar pull	6,400 lbs., max.
Normal load	8 loaded wagons (90 tons).
Maximum load	12 wagons.
Speed	7 miles per hour.
Unloaded speed	about 12 miles per hour.
Yard capacity	,, 100 wagons.
Average weight per haul ...	,, 30 tons.
,, length of haul ...	,, 50 yards.
Annual ton miles	,, 45,000 (excluding locomotive weight).

Design and Construction.—Standard wagon parts can in general be used. Hand brakes are sufficient. Special attention is required to battery box ventilation and insulation. The Midland locomotive is mainly built up of 10-ton wagon parts. The brakes are screw operated, working on a special brake drum to avoid undue wear on tyre brakes owing to grit. A rheostatic brake is also regularly used.

Motors.—Motors should be wound specially for low speed and single reduction gear. The Midland locomotive motors are of 22 h.p. at 220 revolutions per minute, nose-suspended and spur geared 15-68.

Controller.—A single controller is fitted in the driver's cab, it being of ordinary tramway type with rheostatic brake as aforesaid.

Batteries.—Special batteries of the road vehicle type are unnecessary for rail traction. Where the use of battery in preference to conductor supply is justified, a flat plate type battery is sufficiently good for the service, and it is anticipated that battery contractors will guarantee such batteries for up to 10 years at an annual charge of about 10 per cent. to 15 per cent of first cost. On the Midland engine the battery is by the D.P. Battery Co., consisting of 108 train lighting type cells in wooden boxes lead lined, the capacity being 300 ampere hours at the 10 hour rate.

Charging.—Charging arrangements should be sufficiently automatic to enable technically unskilled labour to be normally employed. In the Midland case, charging is done from the Corpn. mains through a motor-generator; the generator is wound with shunt and reverse series coils, so that the maximum voltage that can be impressed on the battery is about 2.6 per cell with 10 amperes only passing, while with 70 amperes passing the voltage becomes only 2.1 volts per cell. The shunt coil can be adjusted by field regulation, so as to bring up the voltage to 2.7 per cell for gassing charges, which are given periodically under skilled technical supervision.

Working.—In a self-contained yard such engines can be driven by yard staff, who can also perform other duties. If the engine has to work on to or across the main line a qualified driver would have to be employed.

Operating Results.—The energy consumption of battery locomotives is necessarily high, the actual consumption varying according to the nature of the service. In addition to the normal losses by frequent stops and braking, there are the special losses in the battery and charging plant. In the Midland case the energy consumption measured at the Corpn. meter averages about 100 watt hours per ton mile. The over-all efficiency is about 50 per cent., *i.e.*, a battery locomotive consumes about double the energy of a conductor-supplied locomotive on the same work. On the other hand, rail bonding in yards presents some difficulties; moreover, in most cases an earthed return is not permissible; motor generator losses are thus inevitable unless double overhead wires are used.

Costs.—A locomotive of the type and capacity shown would cost, pre-war, approximately £900, with, say, about £200 additional for charging plant.

This locomotive replaced five horses and four men pre-war, the annual value of which, at to-day's prices is about £1,600. The working cost of the locomotive for the year 1920 was about £400; adding provision for battery renewal, interest, and depreciation at to-day's prices and rates, the total cost amounts to about £800, so that in similar conditions such an engine could be installed to-day to save £800 per annum over horse shunting.

THE CENTENARY OF THE ELECTRIC MOTOR.

In his presidential address to the Bristol Association of Engineers, at the opening of the present session, Prof. David Robertson (Merchant Venturers Technical College, Bristol University), dealt very completely in chronological sequence with the development of dynamo electric machines since 1821 (just one hundred years ago) when, on September 3rd, Michael Faraday was first able to make a current-carrying wire revolve continuously round a magnet pole, and a magnet revolve round a current-carrying wire.

Until 1883, however, when John Hopkinson, who had in the previous year been appointed consulting engineer to the new English Edison Co., had so modified existing design that the first dynamo ever constructed according to calculation for a definite output was completed by Mather and Platt, but little progress had been made.

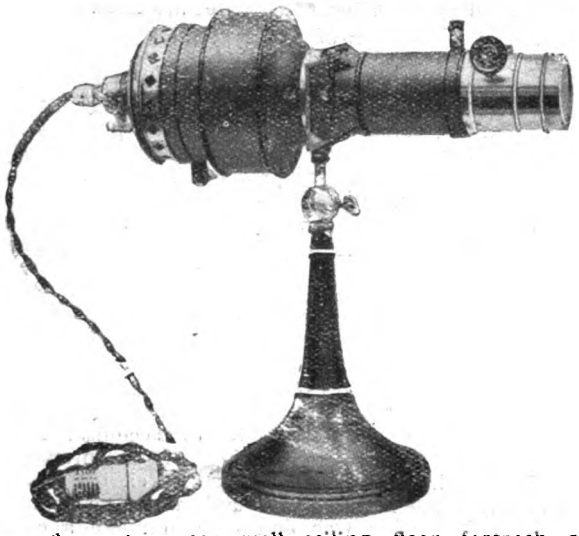
Particulars of this machine, the famous "Edison-Hopkinson" dynamo, seem to have been published in the autumn of 1883, and caused an entire revolution in the art of dynamo design. In his classical paper of 1886, Hopkinson gave full details of this machine and of his methods of calculation, and also particulars of another famous type, the "Manchester" machine, also designed by him for Mather and Platt. In both cases details seem to have become generally known before Hopkinson's paper itself was published. His 1885 paper on the magnetisation of iron gave the data necessary for the calculations; these two papers together with his earlier papers of 1879, 1880, and 1883, supplemented by Kapp's paper of 1885, put the design of dynamo-electric machines on a thoroughly sound footing. It was during this period that the practice of coupling dynamos directly to high-speed engines was developed in this country long before it was adopted elsewhere.

Although multipolar types were used by many of the early designers, the advent of the modern pattern may be dated from 1888, when C. E. L. Brown constructed his well-known machine. Since that time development has mainly been in the improvement of details, in reducing the amount of material required for a given output, in pushing up the size and speed, and in bettering commutation. In the perpetual struggle to get the utmost out of each ounce of material, and to meet the ever-growing demand for size and speed, many old inventions which failed to find adoption at the time of their inception, because they were not required for the small machines of moderate duty then built, have come into their own. Thus, the carbon brush, introduced by Forbes in 1885, is now universal; the commutating pole of Menges (1884) is nearly so; and the elaborate compensating winding of Ryan (1892) is an absolute necessity for the largest generators built for turbine driving. Even then, the limiting size for a direct-current generator is many times smaller than for an alternating current one.

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ILLUMINATED PUBLICITY.

By means of a 100-watt Osram gas-filled lamp in a new type of projector called by the General Electric Co., Ltd., of Magnet House, Kingsway, W.C.2, the "Atrax," very effective advertising designs and announcements can be cheaply displayed. The design or announcement is on a slide, like a magic-lantern slide, and can be projected at



any angle on to screen, wall, ceiling, floor, footpath, etc., and can be adjusted to any dia. between about 5 in. and 4 ft. The dimensions of the Atrax are: ht., 19¾ in.; length of projection tube, 17¾ in.; dia. of tube, 4 in. The weight is about 8 lb. Thus it will be seen that the device is of very considerable advertising value, especially as the brilliance of the image is sufficient to make it visible in diffused daylight. The illustration shows the projector, and indicates how it can be made to project in any desired direction.

ELECTRICITY IN MINES AND QUARRIES.

The second part of the Annual Report of H.M. Chief Inspector of Mines, which has now been issued (H.C. 239 of 1921), shows that the use of electricity at coal mines for all purposes continues to expand. Last year the horse-power of motors installed both above and below ground aggregates 1,082,822 in mines under the Coal Mines Acts, and 20,045 in mines under the Metalliferous Mines Acts. Three-fifths of the total was employed below ground, mainly in pumping and haulage. Electric winding absorbs rather less than one-eighth of the horse-power of motors installed on the surface. Of the total number of mechanical coal-cutters in use, three-sevenths employed the electrical drive, and three-fifths of the mineral cut by machines was obtained in this way. More than one-half the 51,903,450 shots used for blasting in coal mines were fired electrically. Electric safety lamps in use numbered 245,900, while of the 635,127 flame safety lamps in use, two-thirds were fitted with electric igniters. A Miners' Lamp Committee appointed originally by the Home Secretary has been re-appointed by the Secretary for Mines, by whom its terms of reference were extended to deal with the improvement of miners' lamps, desirable alterations in methods of testing and approving lamps, maintenance of lamps in a safe and efficient condition, and safeguarding the general use of safety lamps which give no indication of the presence of inflammable or noxious gases.

There were ten deaths reported in 1920 as due to the use of electricity in and about coal mines, seven of which occurred on the surface. The new Regulations, to which reference has already been made, apply the Underground Electricity Regulations, with certain modifications, to apparatus employed above ground.

The number of mechanical coal cutters in use was 5,073, and 30,746,274 tons of minerals (chiefly coal, but including small quantities of ironstone, fireclay, and ganister) were obtained at 760 mines by the use of these machines.

In the year 1910 less than 6 per cent. of the coal mined was obtained by machines, compared with 13.2 per cent. in 1920. The average output of minerals by machines of the disc, bar, and chain types was 8,441 tons per machine, as compared with an average of only 2,137 tons by percussive machines.

As regards accidents it is interesting to note that, taking all factors into consideration, there has been a notable reduction.

DIARIES FOR 1922.

We have received from Charles Letts and Co. (Southwark Bridge Buildings, S.E.1) a number of diaries for 1922. These diaries form part of a large series which is probably the finest ever published—in various ways little improvements have been made, and one especially, the monthly index in the pocket diaries, is most useful, and will doubtless be much appreciated. Charles Letts have given much thought to the diary requirements of various specialised sections of the community since 1816, and the Business Man's Diary for 1922 (4 ins. by 2¾ ins.) will be found convenient for the majority of busy people as, in addition to the diary space there is in it a lot of very useful information such as postage and parcel rates, licences and stamp duties, legal, metric and British weights and measures, first aid, business abbreviations, miscellaneous engineering, income and interest, sporting, etc. Other pocket diaries have been specially prepared to meet the needs of such diversified classes as boy scouts, poultry keepers, sportsmen, and motorists, and for ladies there is among others the House Wife's Diary and Shopping Companion.

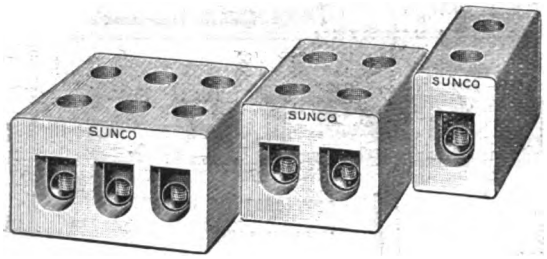
Charles Letts have also an excellent selection of loose leaf books in all sizes, and a wide range of scribbling diaries complete with much useful information, pocket note books, and calendars.

Messrs. D. Harper and Co., Ltd., the diary specialists of 258-262, Holloway Road, London, N., have sent us a copy of their Pocket Diary and Engagement Book, No. 597, of the Cromwell Series. In addition to a useful diary of the vest pocket size, it contains thirty-six pages of good commercial information and data, on the subject of such items as licences, commercial phrases, the addresses of the Consulates in London of foregin countries, nautical measures, and useful addresses for commercial firms, which should prove of value to all engaged in business.

"Calvert's Mechanics' Almanack for 1922," contains, in addition to the usual matter of an Almanack, a very large amount of practical technical and industrial knowledge, and we can recommend it to all our readers as being remarkably good value for the small sum of 6d. at which it is priced.

Rathmines.—At the last monthly meeting of the Rathmines U.C., the chairman (Mr. William Ireland, J.P.) presiding, alarming statements were made regarding the condition of the Council's electric lighting plant, which was stated to be unable to supply any more current in the township. The matter arose on a recommendation of the Lighting Committee that steps be taken to extend the electricity undertaking by the installation of a 750-kilowatt steam turbine at an estimated cost of £30,000. Mr. Russell, who moved the adoption of the recommendation, said that they were bound to extend the undertaking, or they could no longer supply consumers with current. Mrs. Kent proposed postponing the recommendations for six months. In the course of further discussion, it was stated that there were proposals being discussed for obtaining power by harnessing the Liffey, but that although the experts were hopeful, it would take a long time to accomplish it. Nine voted for the amendment and nine against—one member not voting. The chairman gave his casting vote against the amendment, which was defeated, and the recommendation was passed.

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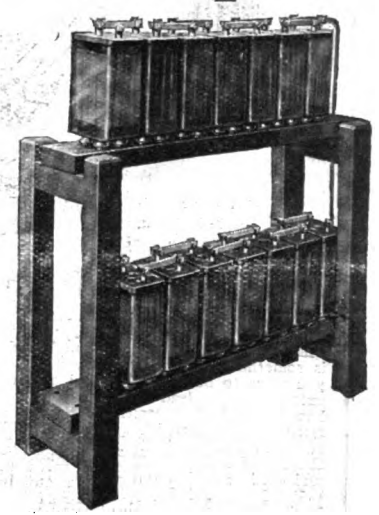
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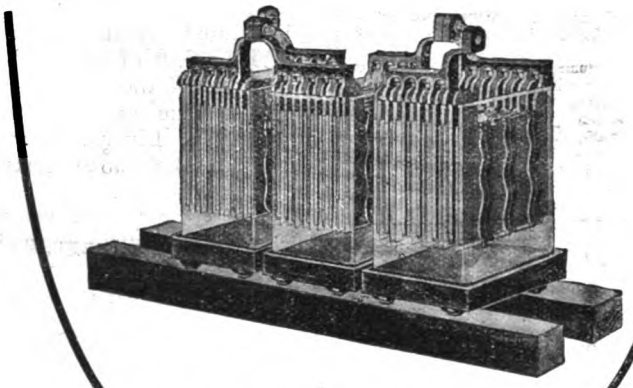
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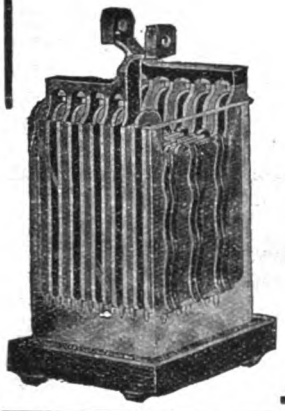
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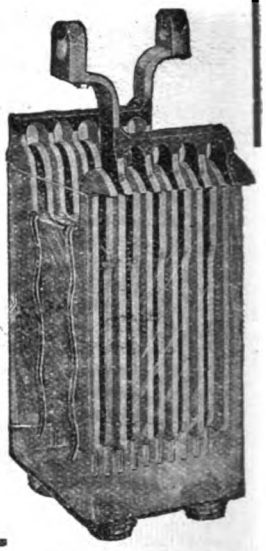
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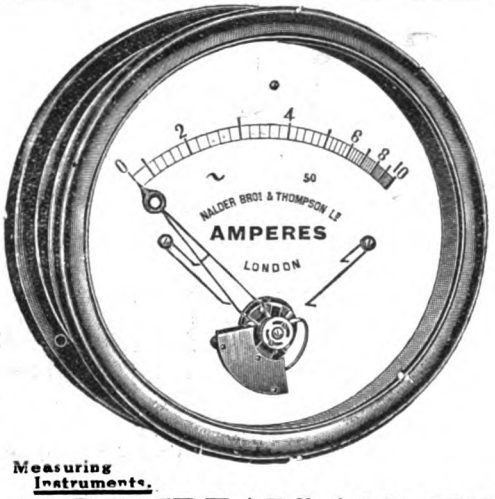


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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

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Current Topics.

Tramways a Fetish.

In spite of their admitted drawbacks, great cost and increasing unsuitability for busy city thoroughfares, it is extraordinary how some municipal authorities still attempt to sponsor tramway extensions, regardless of expense and the general opinion of the ratepayers. Among other cities, Liverpool is perhaps entitled to pride of place for the vigour with which the exponents of tramwey extensions conduct their campaign in the face of equally strenuous opposition. This enthusiasm, although misplaced, is the more noteworthy by virtue of the fact that Liverpool's present tramway service has so little to its credit in the matter of affording a reliable and convenient means of getting about the city.

Just now there is a local movement on foot for considerable expenditure on extensions of the Liverpool tramways, involving, among other things, an encroachment upon certain of the parks, through which it is proposed to carry some of the projected new tracks. The proposals, which involve an initial expenditure of £280,000 on permanent way alone, are to come before the City Council on December 21st, and the Middle Classes Union, representing a considerable body of Liverpool ratepayers, is up in arms and promoting public meetings of protest against such an ill-considered project. It will be recalled that motor-omnibus services have been tried in Liverpool, with, it is alleged, ill success, a considerable financial loss having been incurred over the trial period. The reasons underlying the failure of Liverpool's motor-'bus venture were fairly obvious to the observant, and I referred to some of the contributory causes in my notes at the time.

Evidently to support the tramways propaganda, the city engineer, Mr. J. A. Brodie, recently lectured in Liverpool on motor-omnibus limitations. He contended that unless there was some very considerable advance in motor-omnibus construction and carrying capacity beyond what was at present in sight, an improved and quickened tramway system on the most up-to-date track need not fear the competition of the motor-omnibus or of the electric train for distances of from three to eight miles. As all improvement in street pavement was in the direction of smooth surfaces, no heavily loaded motor-omnibus would be able to travel at the high average speed of the tramway car and the train unless it were provided with a track to itself. Even then it would be somewhat doubtful if the vehicle would decelerate quickly and safely unless guided in some way by projections above the track surface which would protect it against the evil of side-slipping and skidding at high speeds.

We must credit Mr. Brodie with being an idealist on the subject of tramway services, and also with the inception of the fenced off sleeper track tramway system which he has assisted in developing on the outskirts of Liverpool, and which, it would appear, is also projected for certain of the extensions now contemplated. This fencing off of the tramway track, and laying of the permanent way on sleepers, at once brings the tramways into the category of light railways, and allows the cars to maintain a much higher average speed, inasmuch as there is no danger to other traffic, and little or no obstruction of the highway. As such it is to be commended; but, unfortunately, the system is not applicable to the busier city thoroughfares, where most need is felt for a quick and frequent service, and where the ordinary tramway, with its costly buried track and central position, is a constant menace and obstruction to independent traffic.

It is in his criticism of the motor-omnibus that Mr. Brodie discloses such an astounding lack of discernment, and one is prompted to wonder whether he has ever visited London, or travelled on a L.G.O.C. vehicle. In London, motor-omnibuses have passed through all the ills referred to by Mr. Brodie, long since, and emerged triumphant. They admittedly yield a quick, cheap, and extremely flexible service, with the minimum of obstruction of busy thoroughfares. Mr. Brodie refers to the carrying capacity of omnibuses as if they were directly comparable with tram-cars. No such comparison is necessary; thanks to its lower prime cost and the facility with which it can be put on a congested route during rush hours, and as readily removed at periods of lessened traffic, the individual motor-'bus need not accommodate anything approaching the number of passengers which are daily packed into the average tram-car, to their considerable discomfort.

It is impossible to concentrate a number of tram-cars at busy centres to deal with rush-hour traffic. They are tied to their tracks, and often have to travel considerable distances from the car sheds to reach the pick-up stations, returning over the same lengthy routes when the time comes for their withdrawal from service. There is, and can be, no favourable comparison between the two systems in point of first cost, maintenance, and general efficiency of passenger carrying. The records of the London General Omnibus Company constitute an unanswerable argument when it comes to a comparison of the two systems. What has been accomplished in London with the motor-omnibus can be accomplished elsewhere, given the will and the organisation. To spend thousands of pounds on a tramway track, when the same sum would purchase dozens of efficient motor-'buses and ensure a far less costly and more reliable service, is a retrograde step, and it is scarcely to be wondered at that the Liverpool tramway magnates have aroused a hornets' nest by their proposals.

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The Carmarthen Fire.

One sympathises with the inhabitants of Carmarthen over their lack of electric light and power, following the practical destruction of the local power-station by fire. These mishaps, even when unattended by loss of life or injury to individuals, are to be deprecated, owing to the harm they do in the supply industry by disturbing public confidence in the reliability of electricity supply. In the Carmarthen disaster, if the lay Press reports are trustworthy, a most curious fact is disclosed, viz., that from midnight to the morning shift there would be no one on duty at the power-station, not even a night watchman or shift engineer.

The absolute desertion of an important power-station at night, just at the time when it is most depended upon for lighting services in particular, sounds incredible, and on reading the report in the *Western Mail* I at once doubted the accuracy of the statement. One is accustomed to associate all such public utilities as gas, water and electricity supply with the very necessary attentions of a night shift during the hours of darkness, and to learn that there are main supply stations which are left to look after themselves is somewhat of an eye-opener. The Carmarthen fire was first noticed soon after one a.m. by a policeman, and subsequently by people returning from a dance in the small hours. It is conceivable that had there been even one man in attendance throughout the night the outbreak would have been stiffled at the beginning, and the destruction considerably lessened, or even prevented altogether. In the circumstances it would be interesting to learn how many other electricity supply works are left to look after themselves at night.

Congratulations.

London readers, and more particularly those living in or hailing from the old parish of Clerkenwell, will be delighted to hear that Mr. Samuel Insull, the president of the mighty Commonwealth Edison Company of Chicago, has accepted the invitation to be the first Cyrus Fogg Brackett Lecturer at Princeton University. Mr. Insull was born in Clerkenwell, and is one of the many Englishmen who have made good in the electrical industry in the United State. Dr. Edward Weston is another, and the Weston electrical instruments are known all over the globe. It is a pleasure to feel that the old homeland can still quote the names of these and other great men in our industry as proof of our vitality, and I am sure we all hope it will long continue.

Coal Exports.

The last few weeks show a slight increase in the export of British coal is reported—a healthy indication of probable trade revival in the near future. Although the trade is increasing, no profits are being made; in fact, more generally there is a loss. This policy is, however, a sound and far-seeing one, designed to enable us to compete successfully with foreign trade rivals in the overseas markets which were formerly held by Britain, and are so necessary to the maintenance of our external commerce. The permanent loss of all or even a large portion of these markets would prove disastrous to the country as a whole. No sympathy can, therefore, be extended to those miners who clamour for an immediate increase in wages; but they can rest assured that as soon as (and it should not be long delayed) prosperity comes again some profit will be made and wages will immediately rise; at the same time, general trade will revive, and life all round take on a more pleasant aspect.

German Reparations.

I notice with much pleasure that Mr. Highfield, as president of the I.E.E., and on behalf of the Council in full meeting, has sent a letter to the Prime Minister protesting against the suggestion which has been made that part of the sum due to us from old Fritz should be taken in the shape of great generating stations and electrification schemes carried out by them in this country for our benefit. That may sound all right in theory, but if the plant were not nationalised—and we don't want any more of that game—then it would have to be paid for to our Government by the users, and that, of course, would mean so much less work for our own men in the electrical trade. Just as if we were doing so well at present that we don't want the orders. No, thanks. We are not taking any.

ELEKTRON.

WITTON KRAMER ELECTRIC PULLEY BLOCKS.

An electric pulley block, now made by the Witton Kramer Electric Tool and Hoist Works (Proprietors, the General Electric Co., Ltd.), is remarkable for its compactness and lightness. The electrical unit consists of a totally enclosed motor, having a reversing controller forming the other end. The drive from the motor shaft is by a set of spur gearing, the spur wheel being mounted on the worm shaft of a worm gear pulley block of more or less ordinary design, specially strengthened for power drive. The load is lifted by means of an electrically-welded chain and sheave block and hook, special care being taken in the manufacture of this to ensure the chain being a perfect fit in the chain wheel. This equipment which is made for D.C. voltages up to 480, weighs only 2 cwt., and will lift a load of 1 ton at a speed of 10 ft. per minute.

Another speciality of the W. K. Works is the range of drills, of which reference will here be made to two, types R 3 and R 2. By the use of a stand of massive design the former makes an excellent bench drilling machine, the sliding head on which the electric drill is carried being fed by means of a lever. Spring return is provided. By removing four screws the drill can be dismounted for use as an ordinary hand drill. This little machine is equipped with a D.C. 360 watt 500 r.p.m. motor. Its maximum capacity is 29/32 in. in mild steel, and the length of feed is 6 in.

The type R 2 electric drill has a solidly built stand provided with a rising table and a steel standard to carry the drill, which is very sensitive. Two patterns are made, one with an ungeared drill running at 1,050 r.p.m., and capable of drilling holes up to $\frac{1}{8}$ in. in brass and soft metal. The other type has a geared drill running at 510 r.p.m., and will drill holes up to $\frac{1}{4}$ in. in steel, the consumption of these machines being 50 and 100 watts respectively.

The Witton Kramer series also includes other sizes of drills, magnetic drill posts, grinding outfits, commutator grinding equipments, buffing machines, etc.

Xmas ?—The electrician had had a jolly evening and was quietly creeping upstairs. Said a voice: "Watts the matter ? Wire you insulate ? You must get ohm sooner."—From "Higgs Bros. Magazine."

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ELEMENTARY DETERMINANTS.

WITH SPECIAL REFERENCE TO KIRCHHOFF'S LAWS.

By H. P. FEW.
Silver Medallist in Telegraphy, etc.

FINAL ARTICLE.

(*Continued from page* 535.)

In this article we describe a method, due to Prof. J. A. Fleming, of finding the resistances of networks by means of determinants.

Suppose it is desired to find the resistance between two points of any network of resistances which contains no source of electromotive force as, for example, between P and Q of the arrangement shown in Fig. 30. Imagine

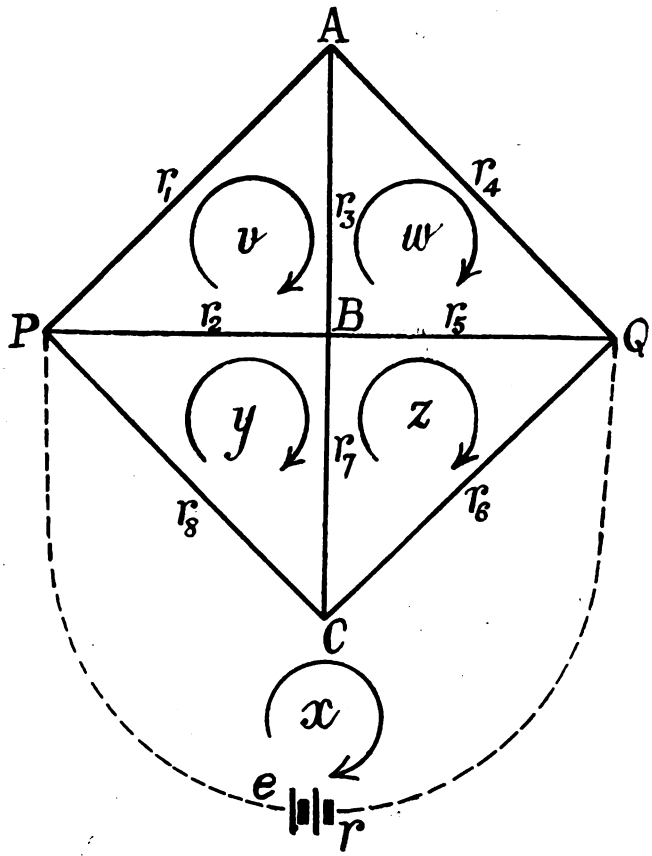


FIG. 30.

the two points to be connected by a wire containing a battery of electromotive force e, the wire and battery together being of resistance r, and suppose a cyclic current x, to flow round this additional mesh. Then, from our preceding work we know that the value of x can be written in the form

$$x = \frac{e\,D_{n-1}}{D_n}$$

where e is the electromotive force, D_n is the denominator determinant of the n^{th} order, and D_{n-1} is the first minor of D_n. Assume R is the equivalent resistance between the two given points, then

$$x = \frac{e}{R + r}$$

Hence

$$\frac{e}{R + r} = \frac{e\,D_{n-1}}{D_n}$$

or

$$R + r = \frac{D_n}{e\,D_{n-1}}$$

The value of r is independent of that of R; it may be of any value; let it be zero. Then

$$R = \left[\frac{D_n}{D_{n-1}}\right]_{r=o}$$

or

$$R = \frac{d_n}{d_{n-1}}$$

where d_n and d_{n-1} represent the values of D_n and D_{n-1} respectively when $r = o$.

In exemplification of the foregoing, suppose it is required to find the resistance of the network between the points P and Q. The cyclic equations are:—

$$\begin{array}{lllll}
(r+r_6+r_8)x & & & -r_8y & -r_6z = e \\
(r_1+r_2+r_3)v & -r_3w & & -r_2y & = o \\
-r_3v & +(r_3+r_4+r_5)w & & & -r_5z = o \\
-r_8x & -r_2v & & +(r_2+r_7+r_8)y & -r_7z = o \\
-r_6x & & -r_5w & -r_7y & +(r_5+r_6+r_7)z = o
\end{array}$$

Forming the determinant for x—

$$x = \frac{\begin{vmatrix} e & o & o & -r_8 & -r_6 \\ o & r_1+r_2+r_3 & -r_3 & -r_2 & o \\ o & -r_3 & r_3+r_4+r_5 & o & -r_5 \\ o & -r_2 & o & r_2+r_7+r_8 & -r_7 \\ o & o & -r_5 & -r_7 & r_5+r_6+r_7 \end{vmatrix}}{\begin{vmatrix} r_6+r_8 & o & o & -r_8 & -r_6 \\ o & r_1+r_2+r_3 & -r_3 & -r_2 & o \\ o & -r_3 & r_3+r_4+r_5 & o & -r_5 \\ -r_8 & -r_2 & o & r_2+r_7+r_8 & -r_7 \\ -r_6 & o & -r_5 & -r_7 & r_5+r_6+r_7 \end{vmatrix}} = \frac{e}{R}$$

since $r = o$. Whence

$$R = \frac{\begin{vmatrix} r_6+r_8 & o & o & -r_8 & -r_6 \\ o & r_1+r_2+r_3 & -r_3 & -r_2 & o \\ o & -r_3 & r_3+r_4+r_5 & o & -r_5 \\ -r_8 & -r_2 & o & r_2+r_7+r_8 & -r_7 \\ -r_6 & o & -r_5 & -r_7 & r_5+r_6+r_7 \end{vmatrix}}{\begin{vmatrix} r_1+r_2+r_3 & -r_3 & -r_2 & o \\ -r_3 & r_3+r_4+r_5 & o & -r_5 \\ -r_2 & o & r_2+r_7+r_8 & -r_7 \\ o & -r_5 & -r_7 & r_5+r_6+r_7 \end{vmatrix}}$$

The *form* of this expression for R merits close scrutiny. It will be observed that—

(1) The dexter diagonal of the numerator consists of the sums of the resistances bounding each mesh, beginning with the added mesh, and that these resistances are all positive.

(2) The constituent at the point of intersection of any row or column represents the resistance separating the two meshes, whose boundary resistances are proper to the row and column, with the minus sign prefixed.

(3) The zero constituents are those common to the row and column proper to any two meshes which are non-adjacent.

(4) The numerator determinant is symmetrical about the dexter diagonal, i.e., that part of the determinant above the dexter diagonal is the reflection in a mirror of that part of the determinant below the dexter diagonal.

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(5) The denominator determinant is formed by deleting from the numerator determinant the first row and first column.

We are thus led to formulate the rule :—*Join the two points of the network between which the resistance is required by a conductor whose resistance is assumed to be zero, calling the mesh thus formed the added mesh; for the numerator of the joint resistance write down a determinant whose dexter diagonal consists of the sum of the resistances bounding each mesh, beginning with the added mesh; the other constituents common to any row and column being the resistances separating the two meshes proper to the row and column, such constituents being zero for any row and column proper to any two meshes which are non-adjacent.*

As exemplifying this rule, let us take Fig. 30, and suppose each conductor between P and Q is of 2 ohms resistance. Write down the quantities representing the numerator thus :—

	x	v	w	y	z
x	4	0	0	−2	−2
v	0	6	−2	−2	0
w	0	−2	6	0	−2
y	−2	−2	0	6	−2
z	−2	0	−2	−2	6

The added mesh is x, and the sum of its bounding resistances is 4 ohms, and we therefore write down 4 at the intersection of the x row and column, i.e., in the first place of the dexter diagonal.

The sum of the bounding resistances of each of the other meshes is 6 ohms, and we therefore write down 6 for the remaining constituents of the dexter diagonal.

The bounding resistance between the x and y meshes is 2 ohms and therefore we set down 2, with the minus sign prefixed, where the x column meets the y row.

The bounding resistance between the x and z meshes is also 2 ohms, and we set down −2 where the x column meets the z row.

Similarly we can write down the resistances of the conductors separating the meshes v and w, w and z, etc., the minus sign always being prefixed.

There is no bounding resistance between v and z, and between w and y, and we therefore set down o at the intersection of the v column and z row, and between the w column and y row.

There is no common boundary between v and x, and between w and x, and we therefore set down o at the points of intersection of these letters.

The complete expression for R can thus be written down :—

$$R = \frac{\begin{vmatrix} 4 & 0 & 0 & -2 & -2 \\ 0 & 6 & -2 & -2 & 0 \\ 0 & -2 & 6 & 0 & -2 \\ -2 & -2 & 0 & 6 & -2 \\ -2 & 0 & -2 & -2 & 6 \end{vmatrix}}{\begin{vmatrix} 6 & -2 & -2 & 0 \\ -2 & 6 & 0 & -2 \\ -2 & 0 & 6 & -2 \\ 0 & -2 & -2 & 6 \end{vmatrix}}$$

To evaluate the numerator of this expression, subtract the fifth row from the fourth row to form a new fourth row; then multiply the fifth row by 2, and add the result to the first row to form a new first row. The numerator then reduces to—

$$\begin{vmatrix} 0 & -4 & -6 & 10 \\ 6 & -2 & -2 & 0 \\ -2 & 6 & 0 & -2 \\ -2 & 2 & 8 & -8 \end{vmatrix}$$

Subtracting the last row from the third row to form a new third row; then multiplying the last row by 3, and adding the result to the second row to form a new second row, the last expression reduces to

$$-2 \times 2 \begin{vmatrix} -4 & -6 & 10 \\ 4 & 22 & -24 \\ 4 & -8 & 6 \end{vmatrix}$$

which expanded gives—

$$-4 \times 4\{(-30 \times 16)-(30 \times -14)\} = 960.$$

To evaluate the denominator of R, subtract the third row from the second row to form a new second row; then multiply the third row by 3 and add the result to the first row. The expression reduces to—

$$-2 \begin{vmatrix} -2 & 16 & -6 \\ 6 & -6 & 0 \\ -2 & -2 & 6 \end{vmatrix}$$

which reduces ultimately to—

$$-2 \times -2\{(18 \times 18)-(-12 \times -12)\} = 720$$

so that

$$R = \frac{960}{720} = 1\tfrac{1}{3} \text{ ohms.}$$

This result is obviously correct, for since the resistance of each branch of the network is the same, the potential must fall uniformly from P to Q, and the potentials at the points A, B and C be the same, so that no current flows through the branches AB, BC, and the network reduces to one consisting of three conductors PAQ, PBQ and PCQ in parallel, each of 4 ohms resistance. By the ordinary method of finding joint resistances, we then reach the same result of $1\frac{1}{3}$ ohms.

Examples of this kind can be multiplied indefinitely, and afford good practice in the use of determinants, since they lead to results which may easily be verified. Thus, if each of the conductors of the arrangement shown in Fig. 31 be of one ohm resistance, what is the equivalent resistance between the points P and Q? Answer $\frac{5}{6}$ ohms.

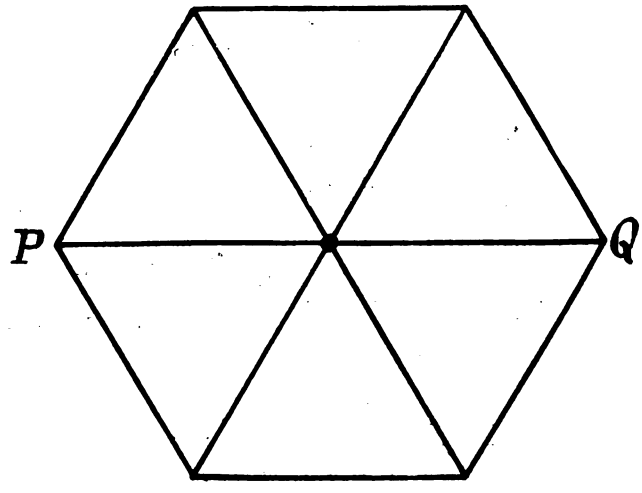


FIG. 31.

Again, in Fig. 32, twelve conductors are arranges to form the edges of a cube. If each of the conductord

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is of 2 ohms resistance, what is the joint resistance between the points P and Q? Answer, $1\frac{2}{3}$ ohms.

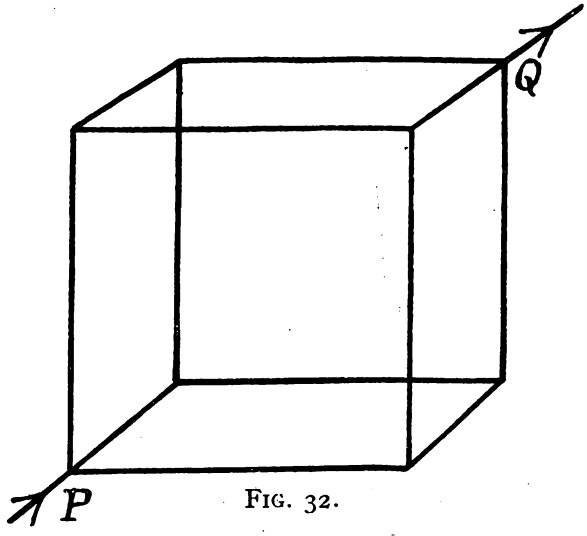


FIG. 32.

As a final example, let us find the resistance of a circle of wire of 0·12 ohm resistance between two opposite points of a diameter removed 30 degrees from a diametral bridging wire of zero resistance.

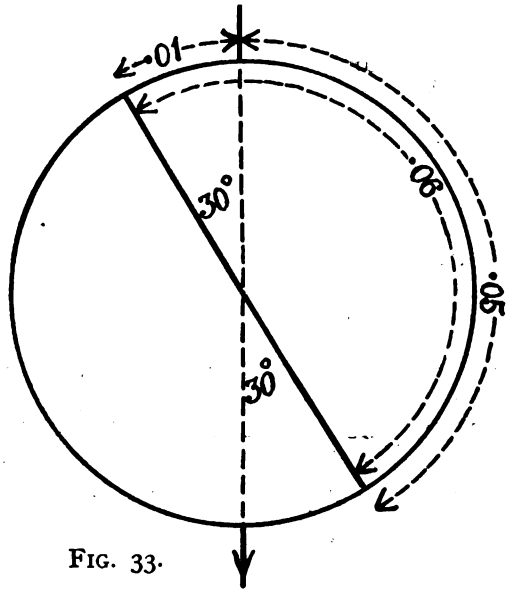


FIG. 33.

The arrangement is shewn in Fig. 33, and it can be redrawn as shewn in Fig. 34.

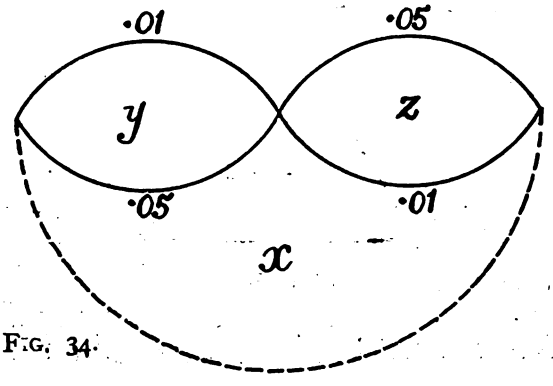


FIG. 34.

Following the rule given above, we can write down the expression for the equivalent resistance in determinantal form—

$$R = \frac{\begin{vmatrix} \cdot06 & -\cdot05 & -\cdot01 \\ -\cdot05 & \cdot06 & 0 \\ -\cdot01 & 0 & \cdot06 \end{vmatrix}}{\begin{vmatrix} \cdot06 & 0 \\ 0 & \cdot06 \end{vmatrix}}$$

which, expanded, gives—

$$R = \frac{(.06)^3 + \cdot05(\cdot06 \times -\cdot05) - \cdot01\,(\cdot06 \times \cdot01)}{(\cdot06)^2}$$

$=0.016$ ohms.

This result is readily verified by employing the ordinary method of calculating conductors in parallel. For—

$$R = 2\left\{\frac{\cdot01 \times \cdot05}{\cdot01 + \cdot05}\right\} \quad = 0\cdot016 \text{ ohms}$$

as before.

For a generalisation of this problem for any conductor formed in a circle, and bridged across by a diametral wire, see page 52, *Kirchhoff's Laws and their Application*, by E. C. Rimington.

THE END.

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 131.

I wish to purchase a 10 ampere prepayment meter for use on a 220-volt D.C. supply. Can any reader advise me upon the best type to buy? I would like a few details about its operation and the necessary precautions to be taken when fixing it.—"WIREMAN."

QUESTION NO. 132.

How do the time limit relays operate on the London and South Western Railway traction units? I understand that the function of these relays is to regulate the period of closing of the main circuit contactors.—"RAIL."

Replies to Questions Nos. 131 and 132 must be received by January 21, 1922.

Answers to Questions.

ANSWER TO QUESTION NO. 126.

The first prize, 10s., has been awarded to "B.L.Y." for the following reply.—

The factor which decides the rapidity at which an electro-magnet can be worked is the time-constant, and this again is decided by the self-induction of the magnetic circuit, and by the electrical resistance. The

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phenomenon of self-induction prevents the current from rising immediately to its maximum value, i.e., a certain lapse of time is required before it reaches its "Ohms law" value. This time constant is numerically equal to $\frac{L}{R}$ where L is the induction of the circuit, and R the resistance. By Helmholtz's law, which expresses the current strength at the end of any short time, we obtain the following formulæ:—

(1) $C = \cdot 634\frac{E}{R}$, and

(2) $C = \frac{t\,E}{L}$, this giving the relation between the current and time.

From this it is seen that the time-constant may be decreased by decreasing the inductance, or increasing the resistance (although the number of turns should be kept as small as possible to keep the inductance low).

If possible, the magnet coils should be connected in parallel, as two coils in parallel have a time-constant of only one-fourth of two in series.

Regarding the iron circuit, the yoke and core should be sub-divided, i.e., built up of stampings as with A.C. magnets to decrease self-induction, and the plunger, or core, should be as light as possible.

To find the co-efficient of induction L, the following formula would be used:—$L = \frac{\phi N}{C \times 10^8}$, that is L = the product of the number of turns of wire times the strength of the field divided by the current, and by 10^8, to bring it to the practical system.

With the question under discussion, L must be found by calculation, but to demonstrate the theory it will be assumed to be 10, the time constant is fixed at $\frac{1}{200}$ secs. = ·005 secs. i.e., $\frac{1}{100}$ sec. each for make and break.

By using formula (2) $C = \frac{\cdot 005 \times 12}{10} = \cdot 006$ amps.

The coil resistance is therefore $\frac{12}{\cdot 006} = 2{,}000$ ohms, the resistance of the leads being negligble.

The actual designing of the relay may now be fairly accurately worked out, taking all the above factors into consideration, although it must be stated that it is to some extent a matter of experimenting and noting results, owing to uncertain factors which can only be approximately estimated.

The writer does not know of any books dealing exhaustively with this subject, but for giving a thorough knowledge of electro-magnets and the principles of same can recommend either "Solenoids and Electro-magnets" by Underhill, or "The Electro-magnet," by the same author, either of which can no doubt be obtained from the publishers of this paper.—"B.L.Y."

No second award is made.

Decimal Association.—At the annual general meeting, a resolution was passed adopting a step by step policy. Weights are to be dealt with first. Every success to the efforts of the Association towards simplification of the present state of affairs. Another resolution passed was that the present values of the £ and shilling should be maintained, but that the shilling should be divided into 10 pence instead of 12, *i.e.*, the token values of existing copper coins would be increased by 20 per cent.

THE "UTILITY" COOKER-RADIATOR.

The handy device illustrated can be effectively and efficiently used as an electric fire (Fig. 1) or for such cooking

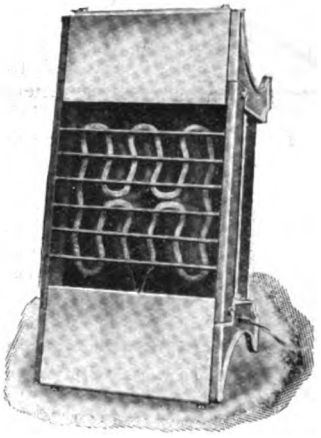


FIG. 1.

operations as boiling, frying, grilling, simmering, stewing, or toasting (Figs. 2 and 3). The illustrations show the ingenious and neat construction. By the withdrawal of

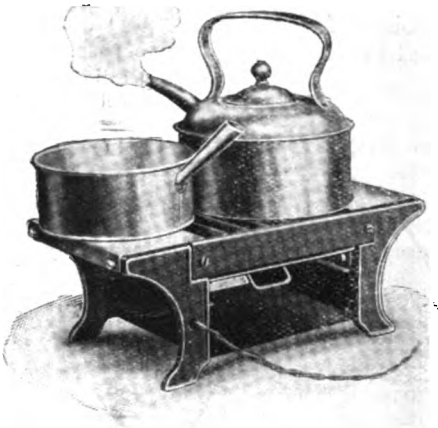


FIG. 2.

five screws the whole heating element, along with the terminal block and flex, can be easily removed. The frame is of sheet steel with cast iron feet, and is fitted with polished aluminium plates on top, thus combining strength with lightness, and the rapid attainment of the normal working temperature. The heating coil (750 or 1,000 watts)

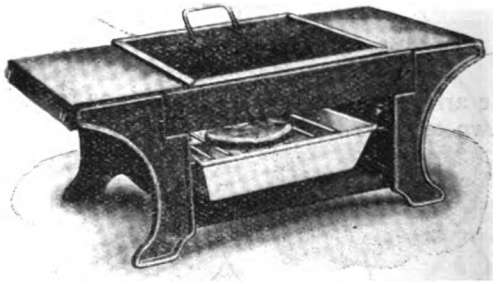


FIG. 3.

is mounted on a set of eyeletted mica supports, which are adequately supported in mild steel channels. A moveable reflector plate of polished aluminium is provided, which throws the heat outwards or upwards, but which can be drawn out and placed above the element when "downward" heat is required for grilling, etc.

It is of British manufacture, and is marketed at a low

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price, by Electrical Utilities, Ltd. (1 and 3, Shelgate Road, Battersea Rise, S.W.11). The weight is 4½ lb., the dimensions 12 by 6 by 4½ ins., the cooking space 8 by 6 ins., and the grilling space 6 by 6 ins.

COLLIERY ELECTRICAL SUPPLY.

At a meeting of the Yorkshire Branch of the Association of Mining Electrical Engineers in Leeds, the President (Mr. F. W. Harbottle) in the chair, an interesting discussion followed the reading of a paper by Mr. Robert Nelson, formerly H.M. Electrical Inspector of Mines, in which he contended that colliery concerns do not always take full advantage of the opportunities offered of purchasing electricity instead of generating it. In his opinion, full consideration would lead to a wider adoption of electricity supply from a public source and would eventually prove to be a considerable contribution to the economics of the coal industry and through it to the economics of industry in general. In the course of the ensuing discussion, the opinions expressed were in favour of a public supply as a stand-by, but a preference was generally expressed by the speakers for private generating as a main supply. Super-power-stations, it was also contended, should be located as near collieries as possible in order to avoid the cost of coal transportation. In summing up the discussion, the president (Mr. F. W. Harbottle) said he considered that if a colliery took its supply from a power company, the colliery company would be relieved of a great deal of trouble. He also alluded to the question of linking up collieries so as to employ one electric supply undertaking. A great saving of power, he contended, would be secured by what might be called a co-operative system of generating electricity at collieries and using the power at the collieries.

FLOOD-LIGHTING AT A LARGE LONDON STORE.

The two illustrations herewith show the new Selfridge Building in Orchard Street, London, by night; and it cannot but be agreed that the complete recently installed system of flood-lighting throws the details of the columns and cornices into relief in a particularly striking manner.

The flood-lights, which are of a standard design, manufactured by the General Electric Co., Ltd. (Magnet House, Kingsway), consist of a solid copper body, lined with sectional parabolic reflectors of mirror glass. They are equipped with 400-watt Osram gasfilled projection-type lamps, with specially concentrated filaments. Flood-lighting has enormous possibilities for publicity and spectacular display, and credit is due to Messrs. Selfridge, Ltd., for being the first, so we believe, to apply flood-lighting to a large London store, and to the G.E.C. Illuminating Engineering Dept.—who designed the installation.

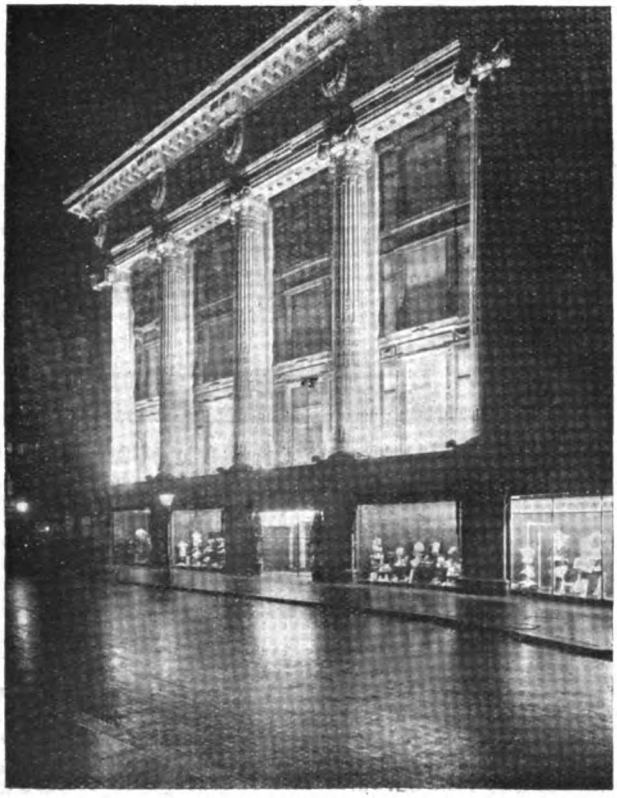


FIG. 1.—FLOOD-LIGHTING OF SELFRIDGE'S NEW BUILDING.

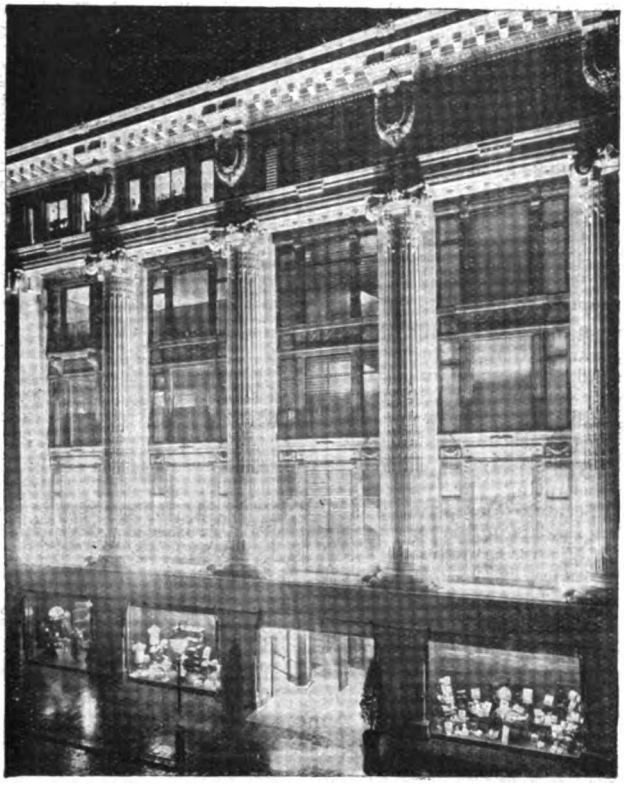


FIG. 2.—ANOTHER VIEW OF SELFRIDGE'S, TAKEN BY G.E.C. FLOODLIGHT.

Belfast.—A very grave position in connection with the "key" men of the Corp. Electricity Station was averted on the 1st inst. The affected men are members of the technical staff at the station, and through the assistant secretary of the E. P. E. A. they intimated that if the conditions of employment and schedules of salaries in their entirety, in respect of salaries of staffs in electricity undertakings, were not applied to all of them they would withdraw their services at 3 p.m. on that date. As a result of a conference between the Electrical Committee and the representatives of the staff, a settlement was agreed upon by which, pending the introduction of a new scheme on the 2nd Jan. next, the Committee's resolution of the 18th Dec., 1920, confirmed 3rd Jan., 1921, would be applied to all the members of the technical staff at the electricity undertaking in the manner set out in schedules above referred to. Councillor Jamieson in moving the confirmation of the settlement said that the city electrical engineer might have been able to carry on for three or four days, but eventually an undesirable struggle would have resulted. After some very caustic comments on the tactics of the Electricity Committee by various members of the Corp. on the 1st inst.—the Lord Mayor presiding—the agreement was ratified.

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Various Items.

The Water Power Resources Committee.—The Final Report of this Committee has now been issued by H.M. Stationery Office.

Meetings.—The Junior Inst. of Engineers will meet on Friday, 16th inst., at Caxton Hall, at 8 p.m. Lecturette: "Notes on Searchlight Construction and Operation," by A J. Simpson (Member). Slides. Also on Friday, 30th inst., at 8 p.m. Questions and General Discussion.

Belfast.—A 30 cwt. two-phase arc furnace, supplied by Electro Metals, Ltd., has been installed in the new steel foundry of Messrs. Sutherland, Ltd., Current is taken from the Corpn. three-phase mains, and transformed to the requisite voltage two-phase, by transformers connected on the Scott system.

The Electro-Harmonic Society.—The next Concert (smoking), will be held in The Great Hall, Cannon Street Hotel, to-night (Friday) 16th inst., at 8 p.m. Chairman: Sir James Devonshire K.B.E. Mr. Harry Dearth and other well-known artistes will appear so members can look forward to a musical treat.

A.M.I.E.E. Examination.—As a result of the Oct. A.M.I.E.E. examination, 8 candidates have passed the whole examination and 2 have passed in part II. only. Of the candidates who sat for the examination abroad the results are not yet available. In addition, 37 R. E. Officers passed the whole examination, and 18 part II. only.

The History of a Lamp.—This is the title of a new booklet illustrating the process employed in the manufacture of "Sceando" lamps, and as such it will, we are certain, interest all readers of this paper. We therefore counsel early application to Messrs. Crowther & Osborn, of 7, Blackfriars Street, Salford, Manchester, asking for a copy, and mentioning this paper.

The Societe Industrielle d'Electricite (Strassbourg, France) has opened a London Office at 23, Queen Anne's Gate, Westminster, S.W. The Coy's specialities are safety cartridge fuses, called "Eternos." They are interchangeable with "Z" and "Didzed" with other fuses are interchangeable with Continental and American systems.

Pritchett and Gold and Electrical Power Storage Co., Ltd.—Referring to the recent statutory notice in the "London Gazette" we are asked to state that the business is very much alive and is being carried on as usual by the same Directors and Staff under the new title of Pritchett and Gold and E.P.S. Company, Limited. The liquidation of the old company was purely for reconstructional purposes.

Wanted.—A reader who is engaged on important Government work wishes to obtain several copies of "Modern Polyphase Machinery" and the "Applications of Electric Motors to Machine Driving," both by Andrew Stewart, and now out of print. If any reader has a copy which he can spare will he please write at once, stating price, to the Publisher of this paper, at 36, Maiden Lane, Strand, London, W.C.2.

That Christmas Box.—Any reader who is thinking of making a Christmas present to himself, should give serious consideration to the value which is offered in the Practical Electrician's Pocket Book, 1922. For the small sum of 3s. 4d., post free, from Messrs Rentell, one can obtain a real Pocket Book of technical information and data to the extent of 560 pages together with a Diary, and we do not think that better value can be obtained for the money in any other direction.

Export Credits—Some important extensions and modifications have now been made in the Export Credits Scheme under the provisions of the Trade Facilities Act which has recently passed through Parliament, supplemented by certain administrative changes in the regulations governing the scheme. The scheme is designed to finance actual sales, and the Department is not empowered to finance the carrying of stocks either in the United Kingdom or abroad; nor is it proposed to give credits in respect of goods to be shipped on consignment.

Copies of the detailed regulations can be obtained from, and inquiries should be addressed to, The Manager, Export Credits Department, 73, Basinghall Street, London, E.C. 2.

Obituary.—The many friends of Mr. John Gibson will regret to learn of his death (from cerebral hæmorrhage), which occurred very suddenly on Friday last, in London. In earlier days Mr. Gibson was connected with Messrs. Ernest Scott & Mountain, Newcastle-on-Tyne, and Messrs. Holden & Brooke, Manchester, but for the last 15 or 16 years he was prominently associated with the supply business of the Metropolitan-Vickers Electrical Co., and was a director of the "Cosmos" Lamp Co. His loss will be felt most keenly by a very wide circle of friends, with whom he was exceedingly popular, and he leaves a widow and three children to whom our sympathies go out in their sudden bereavement. The funeral took place on Wednesday, 14th instant, at 12 o'clock in the Peel Green Cemetery, near Eccles.

Trade Notes.

Messrs. Higgs, the well-known dynamo and motor makers of Sand Pits, Birmingham, have recently opened a branch at 3, York Street, Manchester, which will attend to enquiries and business in that district.

The Jackson Electric Stove Co., Ltd., have appointed as their agent for Ulster, Mr. Robert Garmany of 1, Union Street, Belfast, who will transact business for them in that area. A range of samples and small stocks will be held at this address for the benefit of their Irish clients and it is hoped they will take full advantage of inspecting these and noting the superior construction and the throughly sound engineering proposition that is being offered.

The output of **E. D. A.** literature, designed with the single eye to Sales Promotion, shows no signs of diminishing. Besides several new cards and leaflets there is a poster bearing the words "Light it the Electric Way—Saves more than it Costs." We can't describe it, and have not the space to reproduce it and, if we could, we could only do it in one colour. We suggest therefore, that you write to the **British Elec. Devpl. Assocn.** (Inc.), at 84, Kingsway, W.C.2, about it.

A publication issued by **Fraser & Chalmers Engng. Works** (Erith, Kent) deals with their patented (water tube) Bettington boilers. These are of improved type with central combustion chamber for pulverised fuel, colloidal fuel, oil or gas firing. They are small, efficient, easy to manage and combine rapid steaming and elasticity in capacity, whereby the advantages of raising steam in minimum time and the ability to carry peak loads are obtained.

On Monday, the 12th instant, **Messrs. Johnson & Phillips, Ltd.,** of Charlton, London, S.E. 7, opened a Branch Office and Warehouse in Liverpool, the address being 57, The Albany, Old Hall Street. Stocks will be held there of V.I.R. Cables, association and non-association, C.T.S. Cables and flexibles, wire armoured cables for ship wiring and also of the cables and fittings for the well-known J. & P. wiring system. The demand for all these products, particularly the two last-mentioned, has increased so greatly in Lancashire, Cheshire and North Wales, during the past three years, that it is no longer possible for the firm to handle the business adequately from their Manchester branch, as they have been doing. Both branches will, however, work in the closest possible touch so as to render the maximum service to customers.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL

DECEMBER 23, 1921.

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THE "CYC-ARC" PROCESS OF AUTOMATIC ELECTRIC WELDING.

Messrs. L. J. Steele and H. Martin dealt fully with the "Cyc-Arc" process of automatic electric welding at the meeting of the I.E.E. on December 1st. The system has developed from the first attempt made by one of the authors in 1917 at stud welding for cable clips by using the metallic arc process with quasi-arc electrodes to deposit a ring of molten metal round the base of the steel stud in contact with the plate, thereby welding the stud to the plate. These experiments showed that great skill was required, on account of the small size of the studs, in order to avoid excessive burning away of the latter, while at the same time effectively melting and penetrating the relatively heavy plate; and the difficulties were such as to make it appear advisable to use bolts or set-screws instead of studs, the heads of which were welded to the plates. Though better results were thereby obtained, special cable clips were necessary on account of the thickness of the bolt heads, and the welds were so unsatisfactory as regards both reliabilty and appearance, though largely on account of the class of labour which was available, that this system of stud welding was never brought into regular use.

It is of interest to note that although at first the studs were retained in position for welding by means of tongs, or their equivalent, held by one operator, while the welding was carried out by another individual, early in 1918 a light magnetic stud-holder was designed and constructed, by means of which the stud was retained accurately in position upon the iron or steel plate, thus eliminating one operator.

The apparatus is now fully developed, and is made in two types, A and B. The former is portable and consists of two main parts—the controller and the welding tool. The controller comprises an automatic timing and control apparatus (the key to the process), reactances, resistances, etc., and an automatically-operated contactor. Type B is electro-pneumatic in operation.

The "Cyc-Arc" process differs from the majority of other welding processes in the fact that each weld takes a relatively heavy rush of current for an exceedingly short time. As, in addition, the supply pressure need not exceed 60 volts, an extremely small quantity of energy is required per weld, *e.g.*, a ½-inch diameter stud weld takes 12.5 watt-hours, or 1/80 kw.h., while a ¼-inch stud weld takes only 2 watt-hours, or 1/500 kw.h.

Although the Type A welding apparatus is being operated satisfactorily direct from the ordinary 60- or 100-volt direct-current welding supply mains on fairly large installations where the supply mains and plant are of considerable capacity, it has, on the other hand, been found necessary to design special supply plant for use in conjunction with the "Cyc-Arc" apparatus in the following cases:—

(*a*) Where the existing welding supply plant is of small capacity.

(*b*) Where no welding supply plant is installed, but electrical supply is available.

(*c*) Where no electrical supply is available.

To meet such cases as (*a*), special "kinetic generators" have been designed, and can be supplied at a relatively low cost. These generators, the rating of which is quite small relatively to the momentary loads when welding, are fitted with flywheels. Each generator is supplied wth a starter, so that it can be run as a motor from the welding supply mains, to which it should be connected as near as possible to the "Cyc-Arc" apparatus which it has to supply.

In the intervening periods between welds, the machine is merely motoring "light" from the welding supply mains, but the moment a weld takes place it automatically becomes a generator, supplying practically the whole of the welding load, owing to the combined effect of the flywheel and the special design and arrangement of its field windings.

The current taken from the welding supply mains when supplying the Type A welding apparatus through this special kinetic generator need not exceed 50 amperes, while its motoring current when running light is only from 12 to 20 amperes.

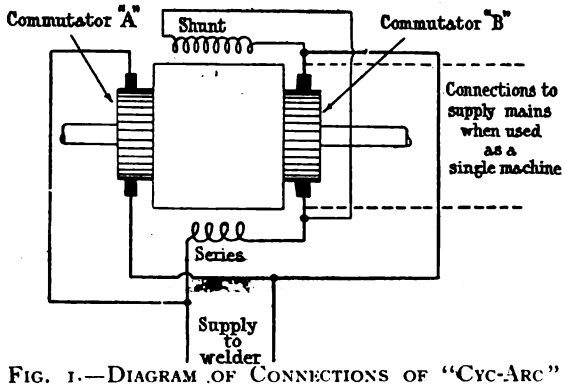


FIG. 1.—DIAGRAM OF CONNECTIONS OF "CYC-ARC" WELDING MOTOR-GENERATOR.

The consequent advantages in minimising peak loads on the welding supply plant, and in reducing the size of the supply mains necessary for "Cyc-Arc" welding, are obvious.

To meet cases such as (*b*), where no suitable welding supply is available for the "Cyc-Arc" apparatus, special kinetic motor-generators have been designed and can be supplied at a moderate cost.

The fundamental principles of the design and operation of these motor-generators are the same as those of the above-described kinetic generator, but each machine can be supplied with a motor designed to suit, not only the voltage, but also the kind of electricity supply which is available, whether direct current or alternating, three-phase or single-phase.

The reason that such motor-generators can be supplied at a cost not greatly in excess of the price of the kinetic generators, is that the driving motors are only of approximately 3 kw. capacity.

These motor generator sets, when running light from the supply mains, take about 1½ kw.h. per hour, this amount being increased to less than 2½ kw.h. per hour when welding the largest size of stud at the maximum possible rate with the Type A apparatus. In addition, attention is called to the fact that the maximum load on the supply mains need not exceed 5 kw., *i.e.*, 23 amperes at 220 volts. d.c., 11.5 amperes at 440 volts d.c., or 6 amperes at 440 volts a.c., three-phase. The complete suitability of such a plant for supply from the smallest power mains likely to be found installed in any works or shipyard is thus also obvious.

For cases such as (*c*) where no electricity supply is available, *e.g.*, works or repair shops in isolated places, or where

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"Cyc-Arc" welding is required to be done by means of a portable engine-driven plant, the kinetic generator has been adapted for use with small petrol, paraffin or steam engines, and can be also supplied in portable form. The size of engine required for the Type A apparatus is only from 5 to 6 h.p., the average load when welding at a maximum rate being about 2¼ h.p., and the petrol consumption being less than 1 gallon per day of 8 hours, during which at least 400 welds should easily be made.

The kinetic generators can also be supplied and fitted with extended shaft, pulley and additional bearing, making them quite suitable for belt-drive from ordinary countershafting.

With reference to the special design of the kinetic generators, it should be noted that direct current is supplied to the "Cyc-Arc" welder under conditons the characteristics of which are unusual, that is to say, in such a manner that the circuit should be devoid, or substantially devoid, of the effect of the inductance of series coils at the moment of striking the arc, while the advantage of cumulative compounding for maintaining the voltage during welding operation is considerable. These objects are achieved by employing a machine comprising a field system, and an armature with two windings and two commutators, each winding being connected to a separate commutator. The brushes of one commutator are coupled in parallel with the brushes of the other commutator to the leads supplying the welder, series excitation being provided by a winding in the circuit of one only of the armature windings, and the shunt winding being conveniently, though not necessarily, excited from the same side of the system.

As will be seen from Fig. 1, the generator has a double winding, and the common field is so arranged that one winding strikes the arc while the other gives the cumulative compounding for maintaining the voltage during the weld. The arrangement also facilitates self-excitation and maintains a steady supply of current to the solenoids, as well as affording a means of compensation for any drop in speed to enable the flywheel energy to be utilised.

The generators are designed for a speed suitable for driving by induction motors having a synchronous speed of 1,500 r.p.m. The same speed is utilised when the generator is driven by a direct-current motor. A cast-steel flywheel is mounted between the motor and the generator, and the drop in speed during a full 2-second weld taking 500 amperes at 60 volts is about 15 per cent. The regulation of these generators is based on the assumption that there is a definite period between each weld in which to restore the energy of the flywheel.

Any undue increase in the motor load, owing to the drop in speed of the machine, is prevented by the compound winding of the direct-current motor, or by the use of a slip resistance in the case of an induction-motor drive.

For stud welding, the input of the motor varies up to a maximum of 5 kw. at the end of a 2-second, 500-ampere, 60-volt weld. The current peak is, therefore, less than one-seventh of that required by a set not provided with a flywheel.

In the paper extracts are given from the test-reports of the Brush Electrical Engineering Co. on the first kinetic motor-generator of the above described type, which they constructed for "Cyc-Arc" welding.

Accrington.—The difficulty following upon the refusal of the Commissioners to approve of electrical extensions is likely to be amicably arranged. Accrington desired to borrow £150,000 for electrical extensions, and they declined to take a supply from Blackburn on the ground that it would cost them £10,000 a year more owing to the high price Blackburn asked than if they generated their own current. The Commissioners have now agreed to sanction borrowing powers if Accrington Council will agree with the Blackburn Corporation to the laying of a 33,000 volt cable between the generating stations of the two towns at an equal cost to each, for the purpose of giving and taking a mutual and reciprocal supply. Accrington have approved of these terms, and have arranged a conference with the Blackburn authority to link up the two towns.

TELEPHONE LINE WORK IN THE UNITED STATES.

By E. S. Byng.

(*Continued from page* 673.)

Wherever it is anticipated that branches will be jointed-in at any later date, arrangements are made to bring out a stub cable containing a number of pairs equal to the sum of the ultimate number of pair in the branch cables, plus a percentage of pairs for flexibility and changes in the distribution. The size of the stub cables, however, does not exceed that of the cable to which they are connected, and preferably they are arranged in even hundreds, to comply with the colour code. The distribution at a given point is confined to one cable, and the cable is so arranged that all its branches are in adjacent manholes. In practice the same numbers are brought out at two or more points, and when relief cable is provided care is taken to avoid any change in the numbering of the cables at the main frame. The first cable feeds a permanent area between the exchange and the suggested relief point, and also a temporary area beyond this point. When the further cable is installed, the original cable is cut at the point of relief without the necessity of transferring any of the stubs or branches. This arrangement is shown diagrammatically in Fig. 1.

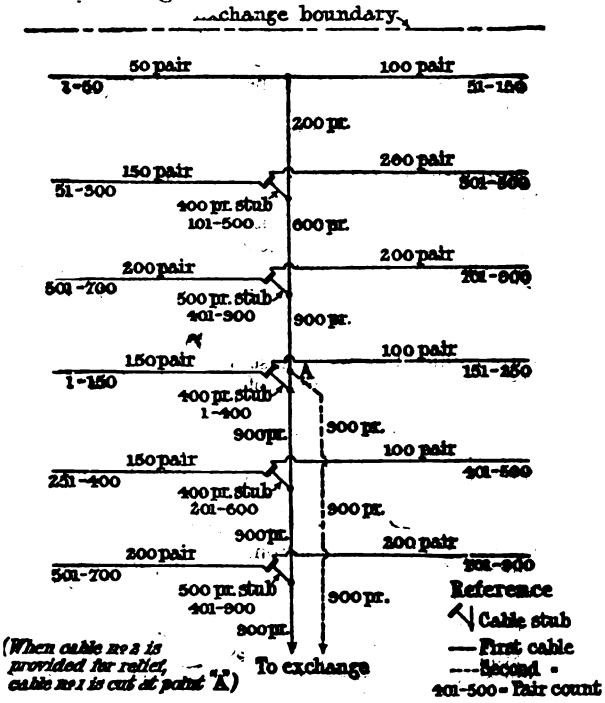


FIG. 1.—CABLE LAY-OUT.

In a rapidly-growing territory the question of relief is often considered when the cable is serving 60 to 65 per cent. of its total pair capacity. It rarely happens that the construction staff is obliged to open joints in the main cables, this process being avoided on account of the possibility of introducing defective pairs and the danger of lowering the insulation resistance.

The plant engineer makes himself familiar with all the details of the plant within his jurisdiction, and by means of card records is kept informed as to the "fill" of the cables, so that new development studies may be made which will enable him to plan any construction work simultaneously with the relief of congestion. To this end he has, in addition to the fundamental plans, a series of maps giving detailed information of all existing plant. These are known as "plant study maps" and are intended primarily as a guide to the plant engineer in efficiently arranging for relief and the extension of plant.

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ENGINEERING AND CONSTRUCTIONAL METHODS.
(1) POLE ROUTES.

(*a*) *Poles.*—The poles, which are generally of chestnut, white, red, or Western cedar, are classed "A" to "G," according to the circumference at the top and the circumference 6 ft from the butt. Reinforced concrete and iron poles are not used, as at present timber can be readily obtained direct from the forests. Where the site of erection is remote from a forest or pole yard, creosoting is regarded as a measure of economy. Locally-hewn timber is frequently butt-treated with creosote oil. A gain of 5 to 15 years may be expected, depending upon the treatment applied. Brush treatment gives a gain of approximately 5 years, while open-tank treatment, providing for the penetration of the preservative to approximately ½ in. will give an increase in life of 15 years or more.

The provision of a reinforced-concrete belt round the pole at the ground line is considered to be beneficial in certain cases, but unless it is properly applied, moisture will accumulate between the reinforcement and the pole and, instead of prolonging the life of the pole, will cause more rapid deterioration.

Main telephone routes generally follow the public roadways, but short cuts across country are frequently made where rights-of-ways can be obtained. When negotiating for private easements a lump sum payment per pole, rather than an annual rental per pole, is offered in complete discharge of the required facility. The amount paid for the facility looks more attractive to the owner, and the clerical work involved in making periodical payments is abolished. Wherever possible the form signed by the owner also gives the telephone company the right to trim any trees along the route so as to ensure a clearance from the wires of at least 18 in. When taking a main route through a forest an attempt is made to minimise the number of faults arising from contact with branches and falling trees by securing a 40-ft. cut through the forest, i.e., a 20-ft. clearance on either side of the route. The size of pole ranges from 30 ft to 35 ft. for main routes, and is about 25 ft. for rural lines. Where a pole route is to be used for distribution within blocks—a case referred to as a "rear property pole line"—the length of pole is frequently only 20 ft.

Poles are spaced from 100 to 150 ft. apart, according to the number and weight of conductors to be carried. Except in special cases long spans are not permitted, as the cost of such special construction is an item of prime importance, in addition to the serious expense of maintenance during bad weather conditions. On toll line routes the stouter poles, classes A and B, are used and are spaced 100 to 110 ft. apart. The tendency to-day is to use the former for open-wire toll lines, and the latter for cable lines. Pole roofs are not used, and it is not considered necessary to provide earth wires as protection against lightning.

Before a pole is erected, locations are decided well in advance of the construction gang by means of ranging rods. Circular pole-holes are excavated by means of special spoon-shaped shovels and long bars. The hole is sufficiently large to admit of the use of the tamping iron all round the pole, but less ground is disturbed than when a stepped rectangular hole is excavated. Pike poles and a tool called the "dead man" are used for pole erection in preference to ladders if a derrick operated from the rear of an automobile truck is not available. In favourable circumstances a construction gang of twelve men can excavate for and erect thirty 25-ft. poles (each carrying one arm) in an 8-hour day, without resource to mechanical labour-saving devices, as mentioned later.

(*b*) *Arms.*—For exchange and toll line construction the standard arm has a normal capacity of 10 wires and is known as a 10-pin cross-arm. Two iron straps, known as "cross-arm braces," are used for preventing tilting on the arms; they do not interfere with the erection of the wires. Fig. 2 shows the fittings for a pole carrying two 10-wire arms. Double sets of arms are used at corner poles with a pull of 35 ft. or more, and also at certain special points, such as railway crossings, long spans, and test-poles.

(*c*) *Pole brackets.*—Where a maximum of only two or three circuits is required for some years ahead, wood-pole brackets are used as they save the cost of providing a 10-wire arm.

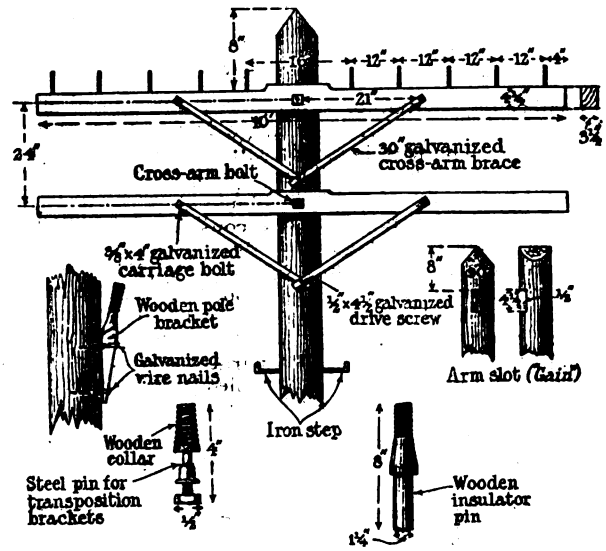


FIG. 2.—POLE FITTINGS.

(*d*) *Pole steps.*—It is not usual to provide pole steps on through routes. Linesmen are provided with climbing irons. At terminal poles and distribution points arrangements are made for permanent stepping.

(*e*) *Staying.*—There are several types of stay rod (guy rod) which can be installed by means of earth borers, some of which are shown in Fig. 3. In general, these rods give

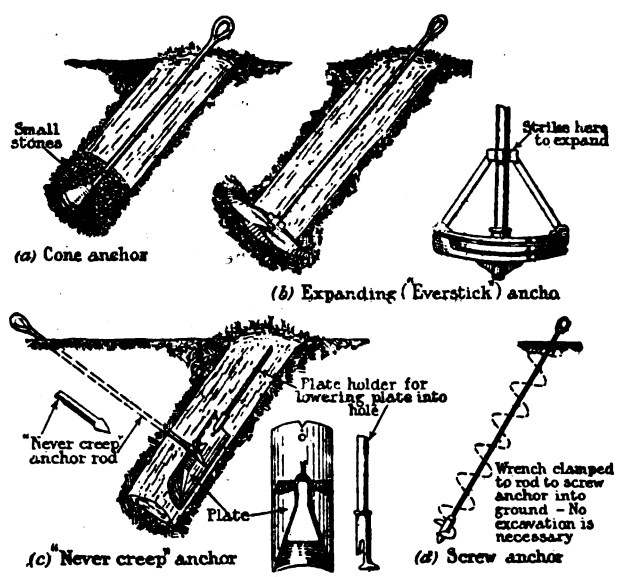


FIG. 3.—TYPES OF PATENT STAY RODS (ANCHORS).

very good service. They can be used for anchoring any size of stay wire, with the possible exception of 16,000-lb. wire. On heavy lines, where the patent rod is not considered to be satisfactory and 16,000-lb. strand wire will be required, logs or planks are used to form he anchor In all types of stay rod the top forms a closed ring, approximately 6 in. above the ground. The guy wire or strand, which is used for staying purposes and also for the suspen-

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sion of aerial cables, is composed of seven strands of galvanised mild steel wire formed into a cable of the following sizes :—

Size.	Diameter of Strand.	Gauge of Wire.	Minimum Breaking Weight.	Weight per 1,000 ft.
lb.	in.		lb.	lb.
2,200	3/16	16 B.W.G.	2,300	75
6,000	5/16	12 B.W.G.	6,000	210
10,000	3/8	11 B.W.G.	11,500	295
16,000	7/16	9 N.B.S.	18,000	415

A turnbuckle, swivel, or other device for adjusting the tension on the wire after installation is not considered to be necessary. The wire is terminated by one or more 3-bolt guy clamps at each end. These clamps are fixed very quickly with the aid of a small pair of blocks which pull up the wire to the required tension. Poles situated at angles are given a slight set and, in practice, it is seldom found necessary to release any clamp subsequently for the purpose of tightening the wire. Strain plates are placed round the pole at the point of making off in the case of 10,000-lb. and 16,000-lb. strand. Where a stay wire is attached to a pole carrying electric light wires, or is immediately adjacent thereto, a strain insulator is inserted in the guy wire as a protection against accidents.

(*f*) *Insulator bolts.*—Insulator bolts (pins) are constructed of locust wood, a local and durable timber. The pin is simply driven into the 1¼-in. hole provided in the arm, and held in place by a nail. On transposition brackets steel pins are used, but they are fitted with wood collars to enable the standard type of insulator to be used.

(*g*) *Insulators.*—Various materials have been tested in the search for an insulator suited to American conditions, and glass, in conjunction with wooden pins, has been found to give the best results. At one time single-shed insulators were used exclusively, but, as the insulation resistance was found to be insufficient for high-grade toll line work, the double-petticoated insulator was introduced. The latter is now used when running or transferring all loaded circuits, and also in non-loaded circuits over 100 miles in length. Its use may also be justified on shorter circuits when insulation conditions are very severe. On subscribers' circuits the single-shed insulator is quite satisfactory. Double-shed porcelain insulators have been used, and there are still many in use; but these are considered obsolete, and glass is now the standard for all purposes.

(*h*) *Class of wire.*—For toll lines a No. 8 B.W.G. (435 lb.) or No. 12 N.B.S. (173 lb.) hard-drawn copper wire is used almost invariably, but for exchange circuits either No. 12 B.W.G. (165 lb.) and No. 14 B.W.G. (96 lb.) galvanised iron wire, or No. 12 and No. 14 N.B.S. (102 lb.) copper wire is employed. Galvanised iron wire is adopted in slow-growing outer portions of large exchange areas, and in all portions of the smaller exchange areas subject to the following conditions :—

(i) That the anticipated development is less than 10 lines in a 15-year period.
(ii) That the iron wire will have a life of 8 years or more.
(iii) That transmission requirements are fulfilled.

Where lines are exposed to moist air or the smoke from soft coal, experience has shown that iron wire will not last eight years. Consequently copper wire has to be used for the majority of open-wire lines in the Eastern States.

Bronze and copper-clad steel are not used to any extent as overhead conductors, except as covered "drop" wires for distribution purposes. These covered wires are also adopted on subscribers' routes where the development studies indicate that the maximum number of circuits in a 5-year period will be six, and where the route does not exceed 1,000 ft. in length. When only three or four of such leads are required arms are not provided, small iron brackets carrying porcelain knobs being fitted on the pole. The number of open wires for local routes is limited where possible to 30, i.e., the full capacity of three 10-wire arms. When the number of circuits exceeds the figures mentioned it is probable that cable can be justified at the outset. The joint use of poles for telephone and electric supply wires is greatly encouraged. The advantages are mutual, particularly on small routes used for distribution purposes.

(*To be continued.*)

SALESMANSHIP IN RELATION TO ELECTRIC POWER-DRIVEN MACHINERY IN THE HOME.

At the second of the Salesmanship Conferences, promoted by the E.D.A., Mr. J. W. Beauchamp, who occupied the chair in place of Mr. S. T. Allen (chief engineer of Wolverhampton and president of the I.M.E.A.), who was unfortunately recalled by telegram at the last moment, was able to announce that already very considerable interest had been aroused in the provinces, and similar meetings were to be organised at various centres.

At last Friday's meeting, Mr. E. R. Morton (sales manager to the Sun Electrical Co., Ltd.) opened a discussion on salesmanship in relation to electric power-driven machinery in the home. He treated the subject in a most able manner on lines generally to be expected, pointing out the absolute necessity for salesmen having a thorough knowledge of the appliances they were selling and of all matters incidental to their use, the futility of running down competing appliances, the need for truthfulness, the importance of getting the prospective producer thoroughly interested before mentioning cost, and the desirability of subsequent calls during the first few months at least after a sale has been effected. Suggestions were also given for preliminary advertising. With regard to washing machines, Mr. Morton laid emphasis on the great saving effected by their use as compared with the sending of washing to laundries, and also as compared with the cost of the washing being done at home by the aid of a washer-woman, the figures given being 10½d., 23s. 6d. and 9s. 6d., respectively. The value of hire-purchase terms in securing business was also dealt with, as even then a saving can be shown, while ultimately, of course, the only cost is that for current. Hire-purchase terms could be contrasted with the monthly cost of a servant to do the work.

The discussion supported Mr. Morton's plea for the necessity of salesmen using the appliances they were selling in their own homes, and also for their being enthusiastic about the appliances. The keynote might well be said to be *use and enthuse.*

Various suggestions were made, but except that the necessity for further educating the public in the real advantage of the electric way by means of advertisement, continual demonstrations on the large scale and the importance of getting at architects and builders to ensure that future building be done with a view to an extended general use of electricity being provided for, there was little of a constructive nature said.

It is regrettable to find that so many in our industry still look forward to the future, awaiting someone else to do the pioneer work for them, instead of tackling the problem now. Whatever benefits can be introduced into future houses and how many houses are still without an electrical supply even for lighting, is beside the point. The fact is that there are over a million houses wired for electric light, and existing appliances, (washing machines, vacuum cleaners, dish-washers, etc.), are quite suitable for general use in existing circumstances, and if only ten per cent. took up the use of these appliances *now* our manufacturers would have all the work they want. Once more, *use and enthuse.*

The next meeting will be held on Friday, January 20th, 1922, at 8 o'clock, at the Chartered Inst. of Patent Agents (Staple Inn Buildings, W.C.1), when, under the chairmanship of Capt. J. M. Donaldson, a discussion on "Salesmanship in relation to Electric Heating and Cooking" will be opened by Mr. W. A. Gillott.

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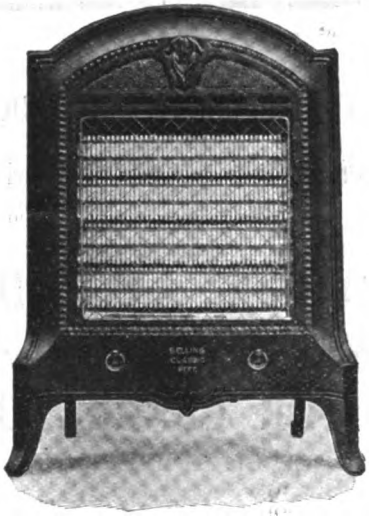
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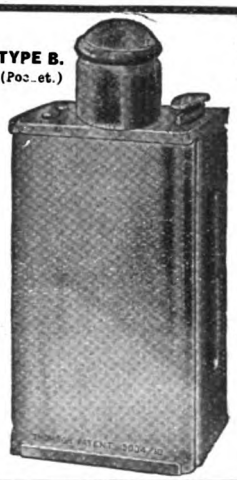
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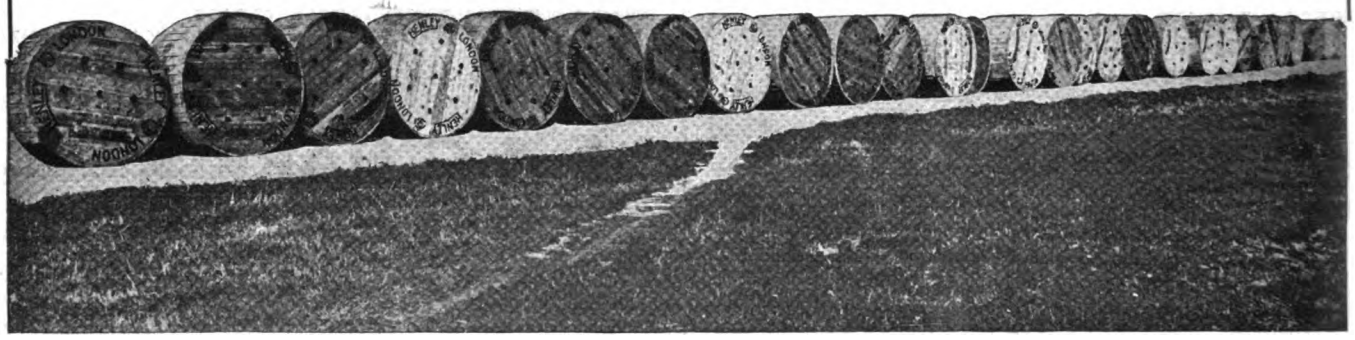
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2460 Gerrard.

Current Topics.

A Merry Christmas.

Once again I wish all my readers the time-honoured Compliments of the Season. Peace and Good Will would seem more than ever assured at the end of what has been a very disappointing year to many of us. Trade prospects are improving gradually, as indicated by the Christmas shopping which has been exceptionally brisk, especially in electrical goods, a happy augury for the New Year. According to reports numerous important electrical projects are scheduled for execution during the twelve months just ahead of us, and, although unemployment will, I fear, have rendered Christmas festivities difficult for many wage-earners, the spirit of the season cannot be suppressed. That it may lead to better times ahead is my earnest wish. A Merry Christmas to you all.

Cheaper Electricity.

In a praiseworthy effort to bring down the cost of living, a factor which bulks largely in the happiness or otherwise of every industrial community, the leading organs of the Press have been conducting a campaign of criticism and comparison of ruling market prices for those goods which may be regarded as the real necessities of life. As a result, considerable reductions have been accomplished in the prices of staple foodstuffs, wearing apparel, etc., all of which is to the public good, inasmuch as it assists in increasing the margin of spending power possessed by all classes when their various essentials have been duly provided for. The most prosperous times are those when the workers of the country enjoy a liberal margin between wages and cost of living. All can then afford those little luxuries which add to the amenities of life and raise it above the level of a mere existence.

Moreover, the capacity of a large percentage of our population for buying goods other than absolute necessities makes for increased trade all round, because the general demand for goods of all descriptions is correspondingly increased. When times are bad it is only the dealers in foodstuffs who are able to continue in business; the vendors of other commodities invariably feel the effects of bad trade at such times. It is only equitable, therefore, that the retail shopkeeper who derives a living from the distribution of the nation's food and is consequently well established whatever the state of industry, should sacrifice a portion of his profits when the occasion demands, and for the benefit of the rest of the community who are less fortunate.

In the general demand for lowered prices, electrical energy naturally comes in for a share of the criticism, and rightly so, inasmuch as it can now be regarded as a necessity in practically every town as well as in many scattered districts. In this connection, London affords an interesting object lesson in comparative costs per unit of electrical energy which at least one organ of the lay Press has not been slow to recognise and make capital out of. According to the *Daily Express*, the average price per unit in London, which before the war ranged from 1.7 to 2.6 pence, now lies between 2.54 and 6.3 pence, rising in extreme cases to as high a figure as 8d. per unit for house lighting. These are average prices charged by the fourteen municipal corporations and the fourteen electricity supply companies which cater for the metropolitan area.

Obviously there is something radically wrong with an industry of this kind to account for such large discrepancies between the maximum and minimum charges. Yet, if you had the time and the opportunity to interview the accounts section of each of these various undertakings you would probably receive an extremely plausible explanation of the necessity for the present charge; figures can always be made to show a desired result, and clever accounting covers a multitude of delinquencies. Taking the supply industry as a whole, and more particularly that portion of it which caters for the metropolitan area, there are many factors which enter into and control the price at which electrical energy can be supplied to the consumer. When all is said and done, the principal factor is the cost of fuel, and, although we all appreciate the present position in regard to coal prices, there is here no justification for such wide divergencies as are indicated in the above averages.

The average price of industrial coal has fallen from 50s. a ton in 1920 to 31s. a ton to-day, and our lay critic figures the resultant saving to the supply companies who are cited as the worst offenders, at £300,000 per annum on the coal bill alone. Here are some further criticisms which, although the supply undertakings can doubtless explain them away satisfactorily to themselves, assume an ugly aspect in the eye of the consumer who has to pay for the privilege of electric light and power. The companies are putting away far larger sums to depreciation and reserve than are justified, having regard to the high price of electricity. The amount placed to reserve last year by six companies was £394,000, as compared with £150,000 in 1912.

Prices of other commodities used in the manufacture and distribution of electricity have fallen during the past two years. Copper, which two years back realised £95 per ton, has now fallen to £67. Rubber, which in the early winter of 1919-20 was 2s. 6½d. per lb., has slumped to 1s. 2½d. Again, there is the labour cut in the engineering trades which, as our contemporary observes, will transfer thousands of pounds per annum from the pockets of the operatives into the coffers of the companies. It is further alleged that the cost of making connections from the supply mains to house services, formerly borne by the companies, has been transferred to the consumer, who thus

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burden of additional capital outlay. Another point made by this critic is that although in thoroughfares the areas served by different companies overlap, and there are consequently mul- mains, the privilege of choice is not left to the uld-be consumer. The rival companies, by virtue of an agreement, select their own consumers, who perforce pay the standard rate fixed by the undertaking from whom they derive their supply of energy, or live in darkness.

Whilst making due allowance for the object in view of the pressman entrusted with this propaganda, there is nevertheless a considerable stratum of fact underlying his contentions, and, for the ultimate benefit of the supply industry, as well as of the electrical industry as a whole, it is high time that both municipal undertakings as well as companies reviewed their charges for electricity with a view to early reductions. The electrical contracting business, together with the sale of current consuming devices, lamps, motors, fittings and accessories is intimately associated with the price charged for current, and in the natural order of things cheap electricity is essential to a revival in the electrical industry as a whole. Failing these mythical superpower stations which were to give us current *ad lib* at a half-penny or even less per unit, it is up to the existing undertakings to justify their continued existence by cutting charges and practising the most rigid economies in generating costs. Incidentally, it is high time power station engineers in some quarters overhauled their plant and mains. Upwards of seven separate and independent breakdowns in supply have been reported during the past week, all of which redound to the discredit of the electricity supply.

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FOREMEN AND SUPERVISORS.

JOIN THE N.A.S.E.

The scope of the National Association of Supervising Electricians is being enlarged, and, in pursuance of this policy, Mr. A. Brammer was recently appointed full-time general secretary. The appointment has been fully justified, and, coupled with the enthusiastic backing of the members, should enable the association to make great progress throughout the country. District branches are to be formed in Manchester, Middlesbrough, Birmingham, Portsmouth and other centres.

We might here refer in more detail to the association and the qualification of its members. Membership is restricted to those who can show by their past experience that they are thoroughly capable and efficient foremen or supervisors in the electrical industry, and the primary object of the association (which was formed in 1914) is education, carried out mainly by lectures, which are held, free to members and visitors, each month at the St. Bride's Institute, Ludgate Circus, E.C.4. Owing, however, during the war period, to the attitude of some employers towards members of the association, it was compelled to register as a trade union to protect its members, and in many cases has been successful in improving their conditions. As a result of negotiations, the association is recognised by the employers, and an agreement between the National Federated Electrical Association and the N.A.S.E. was accomplished in June last. This agreement gives a definite status to the staff foreman, and sets out in detail certain conditions of engagement and work.

A foreman or supervisor, who belongs to a manual workers' organisation, is liable to find himself in a difficult position, which is not in the interests of the workers or the industry. This difficulty cannot arise with the members of the N.A.S.E., and we would urgently counsel all supervisors and foremen in the electrical industry who are not members of the N.A.S.E. to communicate immediately with the general secretary at the office of the association, 29, Metropolitan Buildings, 63, Queen Victoria Street, E.C.4.

We might add that the next lecture will be given on Tuesday, January 10th, 1922, and the annual dinner of the association will take place at the Restaurant Frascati, Oxford Street, W.1, on Saturday, January 28th, 1922. Tickets 12s. 6d. each. A technical library, employment bureau and legal department are always at the service of members.

Outline of Science.—Part 3 of this Newnes' publication is replete with interesting reading matter, including chapters dealing with the way in which the higher forms of life have developed from the dawn of living matter and the protective devices by which they have been enabled to survive the ceaseless competition existing throughout Nature, finishing up with "The Ascent of Man" from the primitive ape-like type.

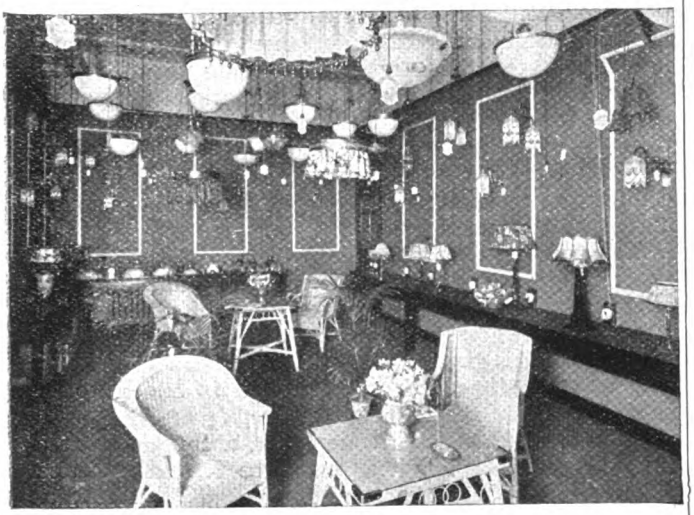
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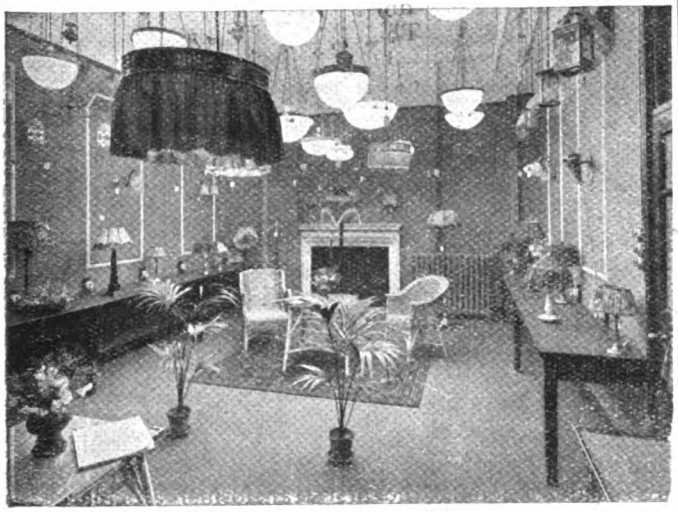
NEW B.T.-H. SHOWROOMS.

A BUSINESS OPPORTUNITY FOR MANCHESTER CONTRACTORS.

We are now able to illustrate the new Manchester showrooms of the British Thomson-Houston Co., Ltd., the opening of which was referred to in these columns some weeks ago.

As may be seen, the fittings showroom is a comfortable and spacious apartment, artistically arranged and decorated. It is essentially a place where the business of choosing and buying electric light fittings may be carried out with comfort, convenience and celerity. The large and varied display covers the whole range





of B.T.-H. lighting units, and includes such items as Mazdalux reflectors, X-ray reflectors, X-colour-ray attachments, eye-rest fittings, semi-indirect fittings, floodlight and spotlight projectors. Every kind and class of lighting is represented by one or other of the scientifically designed fittings displayed. Needless to say, all fittings are equipped with Mazda lamps.

All contractors and dealers in the Manchester district are invited to visit these showrooms, and to bring or send their clients to select fittings, and in every other way to take full advantage of the opportunities for better business afforded by this latest B.T.-H. development.

WALTZ INSTRUCTIONS FOR ELECTRICAL ENGINEERS.

The waltz is a cycle of operations produced by the synchronised movements of two units, known respectively as lady and gentleman.

The perfected adjustments of these movements is accomplished by joining up an untrained unit with a trained, and repeating the cycle until the knowledge possessed by the trained acts more or less upon the permeability of the untrained.

For explanatory purposes let it be assumed that a gentleman is desirous of acquiring the waltz, then the following procedure must be adopted :—

The gentleman must first "meter" lady, preferably a reverser, capable of carrying a heavy load under full pressure without breaking down. This lady must be provided with cast-iron feet, the patience of Job, the temper of an archangel and a high resistance to the caustic comments of other units operating in the same area. It is also necessary that this lady can carry out Terpsichore's law of motion, which can be defined as "That force which can propel ten stone ten yards in ten minutes without disturbing more than ten hairs."

The gentleman places his right arm round the lady's waist (which may be in any position according to the latest fashion), and with his left hand grasps the lady's outstretched right.

The lady, which in this case is, of course, the trained unit, having discovered the line of least resistance, starts off and attempts to perform the series of movements necessary for the cycle.

During this period careful watch must be kept upon the gentleman for the following developments :—

(1) *Hysteresis.*—The gentleman is bound to develop a certain amount of "lag," and it will be found advantageous to employ a "booster" or M.C. to assist the lady.

(2) *Contact.*—Care must be taken that these two units do not come into contact with other units operating in the same area, otherwise there is danger of friction, resulting in a leakage of language along the line.

(3) *Rotating Flux.*—An inevitable development in the gentleman will be the accumulation of electric surgings in and around the head, caused by the constant cyclonic movements. The gentleman appears to be stationary with a rotating field around, and further experiments by the lady are useless until the excitation has subsided, otherwise there is danger of the gentleman trying to choker.

When several units are operating in one large room a "detector" is usually employed to "detect" unengaged units and, more or less, successfully connect them up. It is more popularly known as an M.C.

The training periods generally have an interval halfway through, when it is the duty of the untrained gentleman to find the trained lady and "feeder" until the potential rises to maximum.

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ELECTRICAL ENGINEERING—FINAL GRADE.

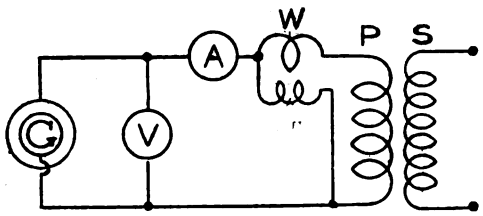
Solutions to Questions set at the 1921 Examination of City and Guilds Institute.

BY EDWARD HUGHES, B.Sc., A.M.I.E.E.

(*Continued from page* 661).

Q. 8.—How would you carry out the following tests on large transformers: (*a*) No-load losses, (*b*) copper losses, (*c*) impedance voltage, (*d*) polarity, (*e*) heating? Show a diagram of connections in each case.

A. 8.—(*a*) *No-load losses.*—The primary of the transformer is connected through a wattmeter *W* and an ammeter *A* to an alternator running at the correct frequency and generating the rated voltage of the



FIGS. 13

transformer (Fig. 13). The ammeter is inserted simply to check the current and thus enable the wattmeter to be worked on its most suitable range. Since the transformer secondary is on open circuit, there is no copper loss in that winding; also, since the current taken by the primary under these conditions is extremely small in comparison with the full-load current, the I^2R loss will be negligibly small. On the other hand, the flux in the core, being dependent upon the applied voltage, is at its normal value. Hence the power indicated by the wattmeter can be taken as the iron or no-load loss of the transformer.

(*b*) *Copper losses.*—The resistances of the primary and secondary windings may be measured by the "bridge" method. To allow for the greater effective resistance of a conductor with A.C. than with D., the values thus obtained should be increased by a percentage depending upon the section of the conductors and upon the frequency. The products of the effective resistances and the primary and secondary currents give the copper losses in the primary and secondary windings respectively.

Another method of determining the copper losses is to short-circuit the secondary winding through a suitable ammeter A_2 as shown in Fig. 14. An ammeter A_1 (reading up to F.L. current), a low-reading

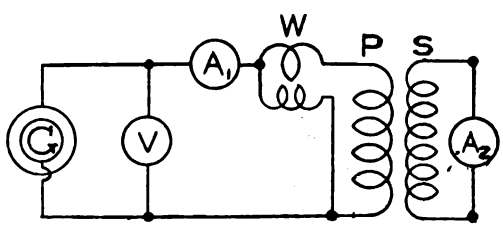


FIG. 14.

voltmeter *V* and a wattmeter *W* are connected in the primary circuit.

After reducing the supply voltage to a very low value, the primary circuit is closed and the voltage increased until A_2 is registering the full-load current. Since the voltage across the primary is now comparatively low, and as the iron losses vary approximately as the square of the voltage, the power supplied to the transformer under these circumstances can be taken as the sum of the copper losses in the primary and secondary windings.

(*c*) *Impedance voltage.*—The impedance voltage is that required to send the F.L. currents through the resistances and reactances of the transformer windings, and is given by the voltmeter reading in the short-circuit test just described. Owing to the secondary being shorted, the e.m.f. induced in that winding is all used up in sending the F.L. current against its impedance; whilst the voltage applied to the primary has one component to neutralise the small e.m.f. induced in the primary corresponding to the e.m.f. induced in the secondary, and another component to send the F.L. current against the impedance of the primary winding. The whole of the applied voltage for the short-circuit test is therefore absorbed in overcoming the resistances and reactances of the primary and secondary windings.

(*d*) *Polarity.*—If a suitable A.C. supply is available, the polarity can easily be tested by connecting two adjacent primary and secondary terminals together and noting whether the voltage between the other two terminals is greater or less than the primary voltage, *i.e.*, whether the secondary voltage is added to or subtracted from the primary voltage.

Another method is to connect an accumulator or a primary cell *A* through a resistance *R* and a switch *S* to the H.T. side of the transformer *T*, whilst a moving-coil millivoltmeter *B* (with centre zero preferably) is connected across the L.T. side. *R* is adjusted until on

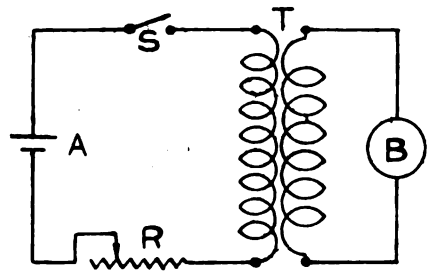


FIG. 15.

closing or opening *S*, an appreciable deflection is obtained on *B*, the direction of the deflection being carefully noted. The test is repeated with the other transformers, the cell in each case being connected with the same polarity in relation to the H.T. terminals, and the L.T. terminals which give the same direction of *B*'s deflection as the first transformer are marked accordingly (Fig. 15).

(*e*) *Heating.*—Since transformers are seldom made singly, it will be assumed that two similar transformers T_1 and T_2 are available. These are connected as shown in Fig. 16, the H.T. windings being joined together; whilst the L.T. winding of T_2 and that of T_1 in series with the secondary of an auxiliary transformer T_3 are connected in parallel across the mains. The correct relationship of the transformer windings has already been determined in test (*d*) and must be

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strictly adhered to in order that T_1 and T_2 may be acting in opposition to each other.

The primary of T_3 is connected through a variable resistance R across the mains, so that by decreasing this resistance, the secondary e.m.f. of T_3 may be increased sufficiently to produce the full-load current —indicated by A—around T_1 and T_2. As the efficiency has not been asked for in this test, no wattmeters have been indicated on the diagram.

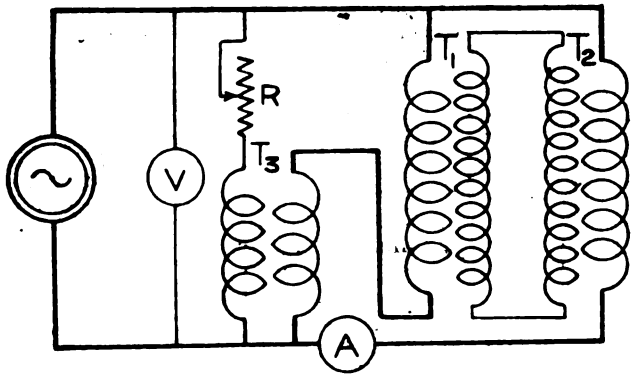


FIG. 16.

The load is kept constant until the temperature has attained a steady value, when the temperature rise can be obtained from thermometers placed at various points. If, however, the temperature rise is being determined by the increase of resistance method, the resistance-measuring instruments should be ready so that readings can be taken immediately the A.C. supply is switched off.

(To be continued.)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final.

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION No. 131.

I wish to purchase a 10 ampere prepayment meter for use on a 220-volt D.C. supply. Can any reader advise me upon the best type to buy? I would like a few details about its operation and the necessary precautions to be taken when fixing it.—"WIREMAN."

QUESTION No. 132.

How do the time limit relays operate on the London and South Western Railway traction units? I understand that the function of these relays is to regulate the period of closing of the main circuit contactors.—"RAIL."

Replies to Questions Nos. 131 and 132 must be received by January 21, 1922.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]

THE PRACTICAL ELECTRICIAN'S POCKET BOOK AND DIARY, 1922. By H. T. Crewe. 560 pp and diary. (Rentell. 3s. net.)—The publishers are to be congratulated on this issue of our old friend, the little red book, as, in spite of its having been thoroughly revised and brought as up to date as is possible, it appears well up to schedule time. In addition to general thorough revision, several chapters have been rewritten and new chapters added, with the result that the editorial pages have been increased in number by about 40, but by the use of superior thin paper the publication is not increased in bulk. Among the new chapters we note one on the motor-converter, one on current limiters, one on the use and maintenance of electric railway signalling apparatus, and one on the care and upkeep of ignition, lighting and self-starting sets for motor vehicles, the two latter being especially welcome, as they treat of matters of ever-increasing importance in a particularly lucid way well calculated to be of the utmost use to those directly connected with the plant. Owner-drivers, as well as chauffeurs, garage proprietors, and mechanics will find the chapter on motor-car electrical sets of especial value as regards the correct use and repair of the electrical equipment, while hints are given on the important points to look for when purchasing new. Designers might also take heed, as, unfortunately much of the electrical equipment in the market is still far from perfect. Coming now to the chapters which have been rewritten, mention must be made of those on small isolated electric plants, steam turbines, Diesel engines, mercury vapour rectifiers (and also the Tungar rectifier for garage charging of accumulators), portable electric tools, electricity in coal mines, cable standards, switchboards, wiring systems, the control of lighting circuits, heating and cooking, furnaces, and welding. This does not include all the revision, but it will serve to indicate that it has really been most thorough, in each case the latest information possible in the compilation of such a comprehensive annual devoted to a rapidly expanding industry being given. Finally, there are the invaluable tables of electric supply undertakings revised up to a few weeks ago, so that here again the fullest information possible is made available. No one in any section of the electrical business can afford to be without this three shillings worth.

WHITAKER'S ALMANACK, 1922. (Whitaker. Paper, 3s.; cloth, 6s.)—This old friend is always welcome, and in the new edition, in addition, to reviews of the important matters dealing with the commerce of the British Empire as well as other foreign countries, additional matter has been inserted in the way of chronological notes and landmarks of a few concise outlines of history from 10,000 B.C. to the present time. This is a practical and indispensable book for every commercial man, and we have no doubt that the sale will continue to increase steadily, more especially in vew of the welcome reduction in price.

ELECTRICITY IN THE SERVICE OF MAN. Vol. II. Sect. 3. By Dr. R. Mullineux Walmesley. 834 pp. and Index. 1,079 Figs. 5 Folding Plates. (Cassell. 15s.)—This volume completes a real up-to-date, popular and practical treatise on the application of electricity to modern life. Both the author and the publishers are to be congratulated on the completion of such a colossal work, which, considering that difficulties always encountered in the compilation of an extensive technical publication are immense, is remarkably complete and representative of the best modern practice. A considerable part of the present volume is devoted to electric traction on rails, tramways and railways being fully dealt with as regards both rolling-stock and track. The procedure adopted to determine locomotive design and performance are also fully treated. The next section deals with the progress in electric incandescent lamp manufacture, and by a perusal of the next following pages a

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general idea can be obtained of the requirements of domestic house lighting. The general question of illumination for exterior and interior spaces for all purposes is also lucidly set forth, the letterpress being embellished by numerous well-chosen illustrations and curves. In this connection we are pleased to see that the proposition of flood-lighting has been adequately presented, while also the general question of searchlight construction and behaviour finds representation. Other sections deal with electro-plating and electro-typing, furnaces, welding and instruments. Being thus complete, the whole work can be said to be of much value to the student studying electrical engineering and to the qualified engineer who wants, in accessible form, the latest information on the state of the varied branches of the electrical art, combined with brief historical notes showing how the present state of efficiency has been achieved, together with general methods of calculation suited to a determination of the economic design of electrical components, their behaviour and efficiency. The need for such a work as this being that no ordinary engineer can carry in his head all the details of such an extensive industry as electrical engineering.

DIARIES FOR 1922.

The annual diary has as usual reached us from our good friends Simplex Conduits, Ltd., and will be just as useful in the future as its predecessor has hitherto been in the past. The front pages contain much interesting matter in regard to the company's manufactures, while at the end there are further useful technical details which will prove of value to electric light and power contractors as well as to all who handle Simplex goods.

Various Items.

Meetings.—On the 29th inst. Mr. P. V. Hunter will deliver a lecture on British Practice in H.T. Distribution before the E.P.E.A., in the Central Hall, Westminster, S.W.1.

Islington.—The L.C.C. has agreed to the Islington B.C. borrowing £8,237 for the purchase of four 2½ electric watering and refuse collecting vans at £1,525 each and two 40-kw. motor-generators, charging switchboards., etc.

Gasfilled Lamps.—The considered judgment of the House of Lords in the appeal by the B. T. H. Coy. against the Corona Lamp Works, Ltd., was given on Monday. It upholds patent No. 10918/13 and therefore the manufacture of gasfilled (half-watt) lamps can only be carried on under this patent.

Scholarships in Engineering.—The British Electrical and Allied Manufacturers' Association (Incorp.) have, on the recommendation of their Education Committee, recently granted six scholarships, each tenable for one year and each carrying a maintenance allowance of £100 and the payment of college fees.

Lancs. Electricity.—A group of authorities in East Lancashire, consisting of Burnley, Accrington, Colne, Darwen, Nelson, Rawtenstall and Brierfield, have submitted to the Electricity Commissioners a scheme for their area, one with which other authorities do not agree, and who will propose an alternative scheme or schemes during the now extended time to March 31st.

Inst. of Production Engineers.—A general meeting (open to all) will be held at 7.30 p.m. on Friday the 30th inst., at the Inst. of Mech. Engrs., Storey's Gate, S.W., when Mr. G. H. Hales, A.F.R.A.S., M.I.P.E. (Member of Council), Works Manager of Messrs. Drummond Bros., Ltd., Guildford, will deliver a paper, to be illustrated by lantern slides, dealing with "The Costing System and its Relation to Production.

Electric Gas Fire Lighter.—As we have previously condemned certain unsafe electric gas fire lighters it is only fair to state that we now find that Messrs. Lord and Shand, Ltd., Buckland House, Millbay, Plymouth, are making a flickering gas lighter which can be connected to the electricity supply. This apparatus has a condenser in series with a sparkling tip, so apparently overcoming some of the dangers. Besides working on A.C. we believe that it will work on D.C. at 200 volts and upwards. However that may be we really cannot understand how it is that any market at all exists for such appliances. To use them the electric supply must be in the house. Why not, therefore, use a clean and economical electric fire or cooker?

Blackburn.—The Licensing Magistrates, on December 15th, approved of a licence for a cinema hall to be erected by Mr. Thos. Fox, Wellington Street (St. John's), at the corner of Bolton Road, at a cost of £15,000.

A Christmas Gift.—We have received from Geo. Ellison, the well-known switchgear manufacturer, of Perry Bar, Birmingham, a charming picture of a young girl attired apparently for a dance or social evening. The implication is that she has changed in the Welfare section of the works, dimly seen in the background, and after a strenuous day in the well-equipped factory is off to spend a few joyous hours in healthful relaxation. At any rate the picture, like Ellison switchgear, is a first-rate production and fit for a place of honour.

New Wiring Systems.—The year 1921 has seen the introduction of several new systems of safe and economical house wiring, and every enterprising contractor, foreman and wireman ought to have a clear working knowledge of them. That information is given in a concise but eminently practical manner in the "Practical Electrician's Pocket Book for 1922," in which the chapter on wiring systems has been most carefully revised and brought up to date. Get a copy promptly. Price 3s. 4d. net, post free, from Rentell, 36, Maiden Lane, London, W.C. 2.

Trade Notes.

The offices and works of **Higgs Bros.,** Sand Pits, Birmingham, will be closed on Dec. 26, 27 and 28.

"Cosmos' Nursery Rhymes" is the title of a booklet giving revised versions of some of the more familiar jingles of our childhood days. It should appeal particularly to children between the ages of 5 and 12, for whom also a colouring competition has been arranged, various suitable prizes being offered. Supplies of the booklet are being distributed by the **Metropolitan-Vickers Electrical Co., Ltd.** (Manchester), to electrical contractors and retailers on the Company's mailing list. In connection with the colouring competition "Cosmos" lamp price list No. 4102/6 is required, and contractors and retailers who have only a small supply should make application for this and other "Cosmos" literature without delay, as we understand the supply is limited.

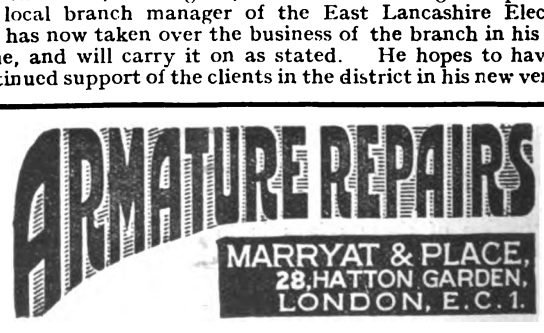
Automatic and Electric Furnaces, Ltd. (281-3, Gray's Inn Road, W.C.1), issue a leaflet in which it is stated that during 1921 German manufacturers have placed orders in England for over 100 Wild-Burfield furnaces. The moral is obvious.

The current issue of the "Engineering Gazette" (published by **Marryat and Place and Marryat and Scott, Ltd.,** 28, Hatton Garden, E.C.) deals as usual with various topics of interest to engineers and contains also some amusing items. Several of the Departments report fair business, and all are able to record a recovery or, at any rate, a partial recovery of trade from the severe slump conditions experienced earlier in the year. The Winding Department, however, is less busy than for some time past, and asks for orders for re-winding dynamos and motors; also orders are required in the shops dealing with magnets, magnetic separators, automatic switchgear, and A.C. motors. On the other hand lift business is good, as is welding, repair and maintenance.

The works of **Bruce, Peebles and Co., Ltd.** (East Pilton, Edinburgh), will be closed from December 30th, 1921, to January 9th, 1922.

The works of **The Midland Electric Mfg. Co., Ltd.,** Barford Street, Birmingham, will be closed from Friday, December 23rd, at 1 p.m., until Thursday, December 29th, at 9 a.m.

Mr. John Cooper, electrical engineer and contractor, of 10, Church Street, Haslingden, who has for a long time past been the local branch manager of the East Lancashire Electrical Co., has now taken over the business of the branch in his own name, and will carry it on as stated. He hopes to have the continued support of the clients in the district in his new venture.



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A POPULAR SCIENTIFIC WEEKLY JOURNAL
ELECTRICITY
A PRACTICAL TRADE JOURNAL
DECEMBER 30, 1921.

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ELECTRIC PLATFORM TRUCKS.

Platform trucks in which an electric driving motor is supplied from a storage battery have proved such useful adjuncts to other effort and time saving appliances in industrial establishments that their use is sure to be very considerably extended. The illustrations herewith show two "Orwell" trucks manufactured by Ransomes, Sims and Jefferies, Ltd., of Ipswich. Type "B" has a loading height of 1 ft. 10 in. and type "C" of 11 in. The maximum load is 4,000 lb. and the speed on the level 5 m.p.h. Gradients of 1 in 9 can be negotiated. The battery equipment consists of 20 cells of "Ironclad Exide" type (Chloride Electrical Storage Co., Ltd.), or 32 nickel-iron cells of the "Nife" type, both giving the same voltage and chargeable off a 55 volt supply. ("Nife" batteries are not fitted to the "B" type trucks.) The power from the battery is supplied to a single series motor in the case of the "B" type, and to two separate series motors in the case of the "C" type. In the former case, the drive is taken through a set of bevel gears to a helical pinion engaging with an internal spur ring bolted to the driving wheel, and in the latter case the drive from each motor is taken direct to the driving wheels by means of a double helical gear.

The "C" type truck can be equipped with an elevating platform, which is raised and lowered through a distance of several inches by means of an electric motor. This equipment is designed to enable the trucks to be backed under ready loaded stillages which can be lifted from the ground so as to be carried by the truck and be deposited where desired. By this means the loading and unloading does not immobilise the truck, which is thus kept in continuous service, and can therefore deal with a greatly increased volume of goods in a given time. Drawbar attachment for hauling two or three trailers is provided and special bodies can be fitted to suit particular requirements. Control is effected by means of a drum type controller with three resistance steps forward and reverse, the controller being interlocked with the brakes (external contracting type) so that the current is automatically cut off as the brakes are applied, and vice versa.

These trucks were shown at the recent Commercial Motor Exhibition, as was a new runabout crane (Mossay and Ransome system). This should prove remarkably useful, as an account of its construction and operation should show. The crane is shown in Figs. 3 and 4, which will be referred to later. The lifting capacity of one size is 15 cwt. at a radius of 10 ft. in any position of the circle, with height of hook 12 ft, no anchorage being required. Similarly there is a standard design to lift 35 cwt. Without going into further details, which can be obtained from the makers, we shall describe the leading features (patents have been applied for).

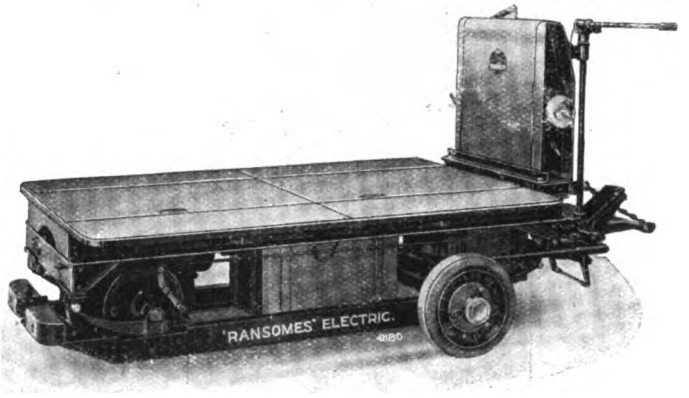


FIG. 1.—TYPE "B" TRUCK.

The turntable, usually provided to enable the crane to swivel independently of the chassis frame, is dispensed with, the crane being rigidly fixed to the chassis of the vehicle which is so designed as to be able to turn on its own axis or run forwards or backwards in a path of any curvature. As the crane is a fixture on the chassis, the jib is always in the same position relatively to the chassis, so that there is no variation

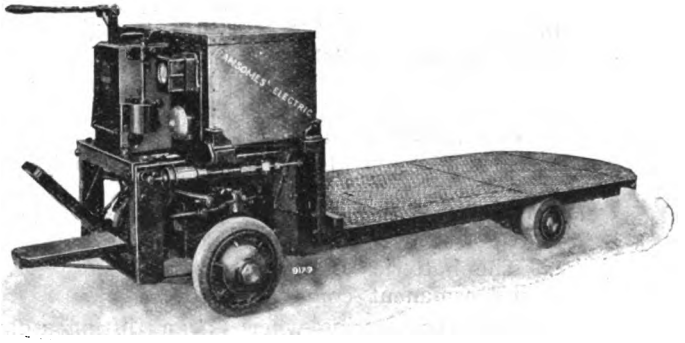


FIG. 2.—TYPE "C" TRUCK.

of the stability factor as the load is slewed; as a result the runabout crane has only about half the weight of a crane truck built for the same service according to the methods hitherto employed, and, furthermore, the pressure on the road remains constant for all positions of the crane, and is kept within low limits by its distribution between four wheels. (See Figs. 3 and 4.) The driving wheels are each driven by a motor supplied by a battery carried on

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the truck, and the steering wheels are able to be rotated in either direction to positions at right angles to the running positions. Just before reaching this extreme position one of the running motors is automatically reversed, so that the truck then rotates about its own axis without any motion of translation.

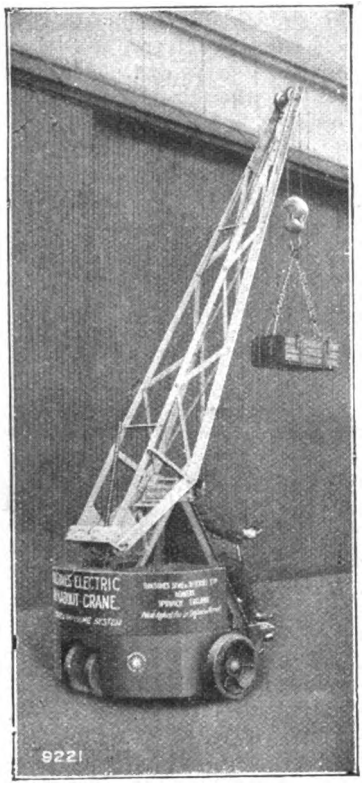


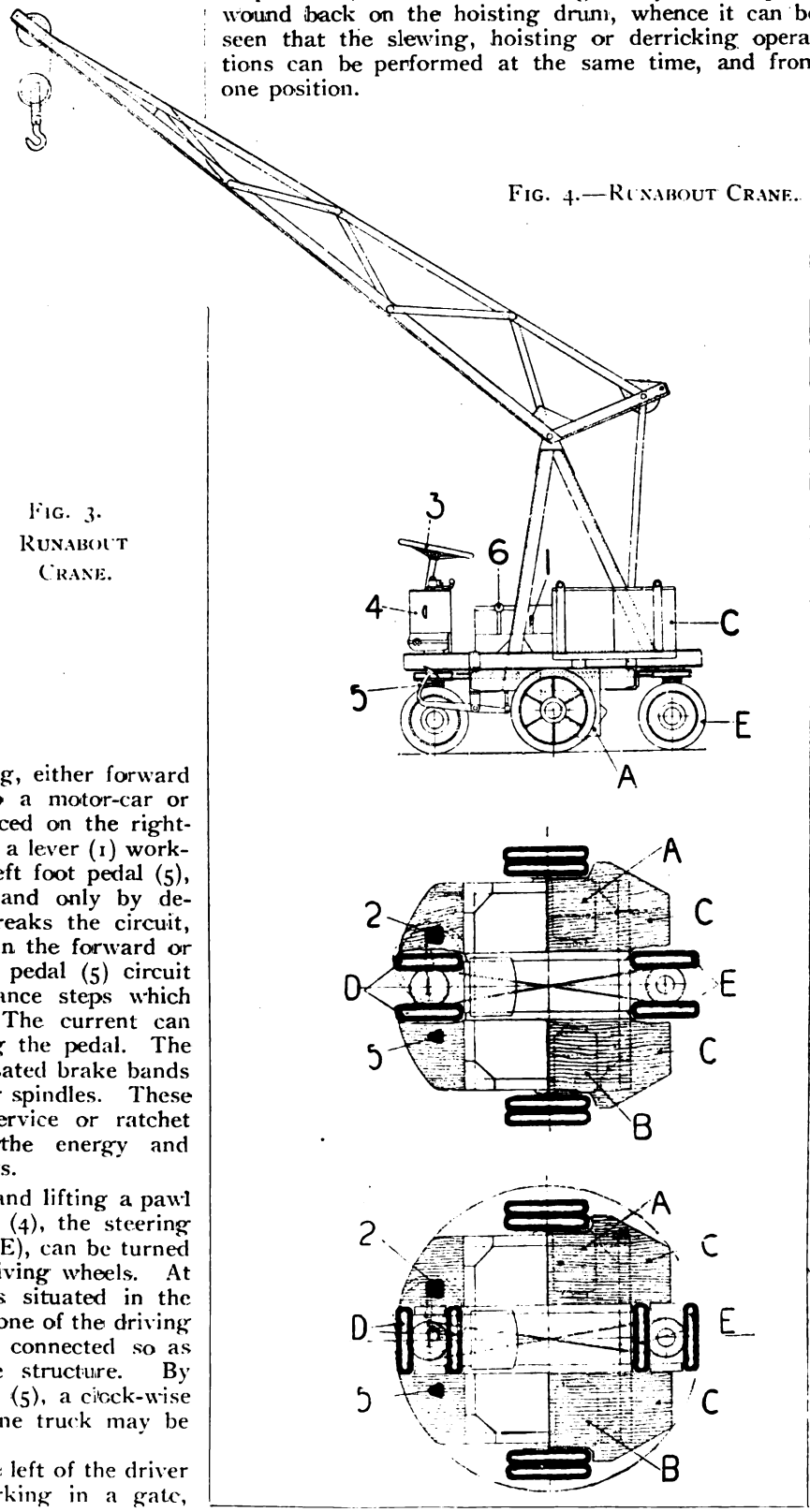
FIG. 3.
RUNABOUT
CRANE.

The truck for purposes of travelling, either forward or reverse, is operated similarly to a motor-car or lorry. The directional controller placed on the right-hand side of the driver is operated by a lever (1) working in a gate, interlocked with the left foot pedal (5), which controls a resistance drum, and only by depressing the pedal control which breaks the circuit, can the controller handle be placed in the forward or reverse positions. By releasing the pedal (5) circuit is made through a series of resistance steps which govern the speed of the vehicle. The current can be cut off immediately by depressing the pedal. The brake pedal (2) actuates two compensated brake bands working on drums keyed on the motor spindles. These brakes can be used either as a service or ratchet brake. The batteries (CC) supply the energy and constitute permanent counter-weights.

By turning the steering wheel (3) and lifting a pawl on the top of the master controller (4), the steering wheels, both front and rear (D) and (E), can be turned and locked at 90 degrees to the driving wheels. At the same time a series of contacts situated in the master controller reverse the field of one of the driving motors (A) or (B), which are thus connected so as to exert a "couple" on the whole structure. By operating the lever (1) and the pedal (5), a clock-wise or anti-clockwise rotation of the crane truck may be attained.

The crane controller is placed on the left of the driver and is operated by a lever (6) working in a gate, controlling the raising or lowering of the hook. The derricking motion of the jib is controlled by the same lever and the mechanism is so arranged as to obtain an approximately horizontal movement of the load, that is to say, when lifting the jib the hoist rope is paid out, and when lowering the jib the rope is wound back on the hoisting drum, whence it can be seen that the slewing, hoisting or derricking operations can be performed at the same time, and from one position.

FIG. 4.—RUNABOUT CRANE.



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SOME RECENT DEVELOPMENTS IN THE DESIGN OF A.C. INSTRUMENTS.

At the meeting of the I.E.E. Informal Section when Mr. C. L. Lipman opened a discussion on the above, some fine examples of the instruments made by Messrs. Nalder Bros. and Thompson were shown. Included was a special sensitive relay, primarily intended for use with Merz-Price and similar systems of protection. It is in principle similar to a moving iron ammeter, having rectangular stampings with a rectangular space cut away from the centre, this space being bridged near the centre with fixed and moving irons in such a way as to leave small air gaps. These irons in the centre are surrounded by three concentric coils, the one carries the fault current and the other two the tripping current for tripping the switch; the moving iron is attached to a pivoted spindle carrying a switch arm, the whole being controlled by a small spiral spring. When a fault occurs, the out of balance current causes the moving member to be repelled from the fixed iron and attracted into a slightly tapering gap until the switch arm closes the tripping circuit through the outer two coils in series. This puts extra torque on the movement to make a good contact on the switch arm, and when this contact is closed the outer coil is cut out, leaving in just enough turns to keep the tripping circuit closed. By this means a maximum number of switches can be tripped simultaneously by a given battery. Once the switch arm of the relay makes contact the process of tripping the main switch must go on until the latter is opened; this breaks the trip circuit, when the relay returns to its normal position, and is thus self-setting.

This construction ensures a quick and certain contact in the trip circuit (as oscillograph records show) and makes the trip proof against violent external vibration, which is decidedly not the case with other relays taking very much more energy to trip. As each type and length of line has different constants, requiring for best results a relay of different impedence, the A.C. coil should be wound accordingly. The relays can be operated by hand, for testing purposes, by means of milled-headed screws at the top of the case.

The switch is capable of closing circuits up to 90 volt-amps, *e.g.*, 3 amps. at 30 volts. In the case of oil switch trips requiring more than 90 volt-amps. to operate them, an auxiliary relay is fitted into the case, which will deal with trips taking up to 2.5 kw. to operate them (*e.g.*, 10 amps. at 250 volts). Only one auxiliary relay is required, whether the primary relay be a single, double or triple pole one. Indicators of the hand-replacable type are mounted inside the relay case in series with the trip circuit of each pole, which gives a positive indication of having operated.

The advantages of these relays are :—

(1) Insensitive to external vibration.

(2) Very low power required to trip 0.01 volt-amps., or 1.10 to 1.20 of the practical setting of an ordinary A.C. relay.

(3) Self-setting, with positive indication of having operated.

(4) Relay contact held in *always* till the circuit is cleared, hence no sparking at relay.

(5) A.C. coil specially insulated on the end turns, and also throughout, to withstand high voltage and high frequency surges.

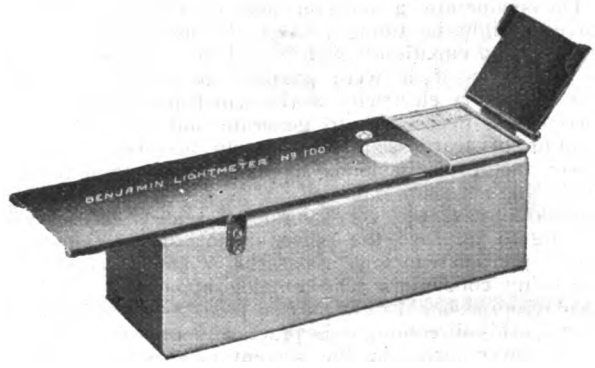
Among the other instruments reference must be made to a three-phase voltmeter similar in appearance to an ordinary voltmeter. It has the usual type of scale, and it may be either moving iron, induction or dynamometer pattern. This instrument indicates the voltage of the three phase circuit and indicates also when a break occurs in the potential transformer or its connections, or the failing of any of the fuses, whether it be a high tension or low tension one. Further, it shows which fuse has blown, or the particular phase in which the break may have occurred, and the direction of phase-rotation in the potential transformer secondary.

THE BENJAMIN LIGHTMETER.

Great advances in methods of using artificial light in factories and workshops have been made during recent years, and have been touched upon in these columns from time to time. That there is a growing recognition of the vital importance of correct lighting in industry is evidenced by the many enterprising concerns who have entirely remodelled their lighting installations and by the official approval now accorded by the Government.

Admitting then the necessity of proper lighting in the interests of production, safety and health, it remains to be decided *how much* light is needed for various industrial processes, and the acquiring of an infallible method of verifying the results by actual measurement.

A little device recently perfected—the Benjamin Lightmeter—meets these requirements completely. It consists of a compact and well-finished light-proof box, utilising inside a small lamp of known candle power



which illuminates a graduated standard surface against which the actual illumination at any point can be compared. No technical knowledge is required to use the instrument effectively, and it can be carried about as easily as a small camera.

It can be connected to any 4-volt (2 cell) accumulator (providing it is in good condition), and a certificate is supplied with each instrument by the manufacturers showing the battery voltage and amperage used in the calibration of the scale. Photometric balance is obtained by moving the top screen backwards and forwards until the grease spot in the centre attains the same degree of luminosity as the comparison screen surrounding it. The illumination in foot-candles is then indicated in the opening immediately above.

To measure candle power the instrument is held at a definite distance in feet from the light source to be measured with the screen directly facing same. The reading in foot candles when multiplied by the distance squared will give the candle power of the source.

The range of the standard instrument is from 0.5 to 20 foot candles, but this can of course be varied for special purposes if desired. Finally, the advantages of this useful device will be apparent to everyone, and one should certainly be in the hands of all works managers and engineers who appreciate the value of adequate illumination. The Benjamin Electric, Ltd., of Brantwood Works, Tottenham, can supply from stock, and will, we understand, be pleased to furnish any further information required to those interested.

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YOUNG BUSINESS MEN.

If your employer does not give you a "Charles Letts Business Man's Diary" this season, invest the small sum asked in one. It will repay you. In addition to convenient diary pages there is a lot of information presented in a handy form for everyday use, and a number of hints pointing out the road to success. Some of these are sure to appeal. Here are two: (1) "The man who measures his business with a foot rule can see only the measurements that exist, but the man who uses imagination can see ahead what *may be*, and seeing the possible, sets to work for its accomplishment." (2) "Business is only a form of teaching. You teach poeple to desire your product; that is selling. You teach workmen how to make the right product; that is manufacturing. You teach others how to co-operate with you; that is organisation. To succeed in business it is necessary to make the other man see things as you see them, which means that you yourself must first see and believe before you can tell another."

THE DISTRIBUTION AND GENERATION OF WATTLESS POWER.

The deliberate generation and distribution of wattless current might be thought to be the most foolish and unnecessary occupation which could be conceived, and so it would be—if it were possible to avoid it! Actually, however, every electricity works which produces alternating current has necessarily to generate and distribute a great amount of wattless power, simply because the average power factor of the loads supplied is less than unity and rarely higher than 0.8.

Undoubtedly, the correct line of endeavour is that of seeking to improve the power factor of individual loads, using phase-advancing apparatus where necessary and penalising consumers who employ apparatus which operates at unreasonably low power factor. Whatever may be done in this direction, it is practically impossible to obtain unity power factor in the system as a whole and, as a matter of fact, the cost of further correction of power factor is apt to become prohibitively high once the power factor has been raised to about 0.9.

The wattless current corresponding to the amount by which the power factor is below unity has to be supplied by the generators feeding the system, and the question arises as to whether it is better to allow the various generators to perform this duty more or less indiscriminately or whether it is better to use a special generator operating at zero power factor to supply the wattless component for the whole network, the other generators then operating at unity power factor.

This problem is discussed in a recent issue of the *Electrotechnische Zeitschrift*, by A. Schmidt, who mentions the fact that in the network of the Minneapolis and St. Paul Electricity Company (U.S.A.), a steam-driven power station is used to supply 30,000 kva. of wattless current during the summer months in order that a water power station at another point in the system may operate at unity power factor and thus take full advantage of the ample water power available during the summer season. This example illustrates one of the advantages of "centralising" the production of wattless current for the whole system. There are, of course, other advantages which are mentioned later.

Conditions will vary widely according to the individual circumstances of particular cases, but it is quite conceivable that concentrating the wattless generation in one station will increase the ohmic losses in the network, because heavy wattless currents may have to be transmitted in some sections of the network to bring the power factor of all the stations (except the correcting one) up to unity. The actual magnitude of such losses is, however, relatively small in comparison with other losses in the system, and the great advantage of the new scheme is that all the generating stations except one operate at unity power factor and maximum possible output. The zero power factor station is, of course, the "sick dog" of the system, but it has only to perform a duty which would otherwise have to be shared by all the stations in the system and, whereas it is possible to provide whatever special plant, supervision and attendance is required at the special station, it would be economically impracticable to do this at every station in the network. In other words, the generation of the inevitable amount of wattless current can be conducted under more favourable circumstances at the special station than it could be if this current were produced indiscriminately by a number of stations.

Theoretically, the wattless power requires no energy to produce it, but in practice there are certain losses to be covered, so that the effective power required is about 10 per cent. of the "wattless" power produced. Even so, however, an alternator operating at zero power factor and supplying 80,000 kva. of wattless power to a system, could be driven by an 800 kw. turbine. The transformers and switchgear between the special generator and the network would, of course, have to be of 80,000 kva. rating. It naturally strikes one that all this plant for the production of wattless current represents a heavy idle investment. This is perfectly true, and the example serves admirably to illustrate the costliness of low power factor, for the equipment employed "idly" at the special station contemplated is no more than would otherwise be operating idly in the various stations of the network, whereas, by providing this special equipment, we release a corresponding kilovolt-ampere capacity of plant in the other stations for really effective generation.

A point which should not be overlooked is that the plant in the zero power factor station can, in emergency, be operated as reserve generating plant, the effective output being limited, however, to the kilowatt capacity of the turbine driving the special alternator. In order to increase the stand-by capacity of the special station, the turbine installed should be of higher rating than is required for the production of wattless current under normal conditions. This may be arranged by tapping the steam from the turbine at an intermediate pressure for heating purposes or for conveyance to low pressure turbines under normal running conditions. In emergency, the full expansion would be conducted in the turbine coupled to the "wattless" generator, which could then supply the full kilowatt output of the turbine to the system at the average power factor of the network.

MUNICIPAL ELECTRICAL "OLD STAGERS."

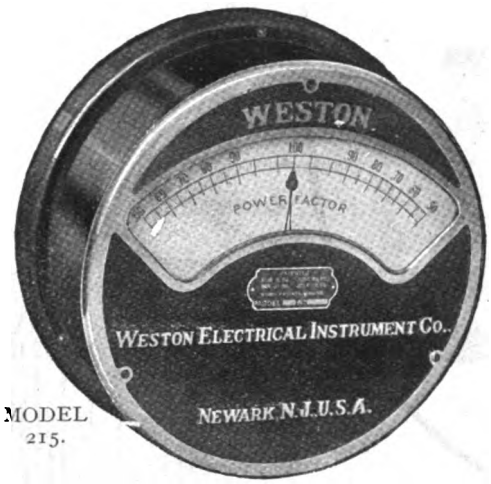
We are pleased to learn that the suggestion that those engaged in municipal electrical work in the early days should meet at a dinner has received a remarkably cordial reception. All those known to be eligible have been asked to attend, but in case there are any who, before 31st December, 1900, were chief engineers, or assistant engineers (electrical or mechanical), and who at any subsequent time became chief engineers in municipal electric undertakings, have been overlooked, the secretary to the committee appointed to organise the gathering would be glad if they would get into touch with him. The secretary is Mr. C. H. Wordingham (7, Victoria Street, Westminster, S.W.1), and the members of the committee—Messrs. S. W. Baynes, J. Christie, R. S. Downe, E. T. Ruthven Murray, H. Faraday Proctor and G. Scott Ram.

The dinner is to take place at the Hotel Cecil on Friday, January 20th, at 7 p.m., and will be of an informal nature. In fact, we expect it will be very jolly.

It is proposed to invite the following as guests:—Mr. S. T. Allen (President of the I.M.E.A.), Mr. H. Booth and Sir Harry Haward (the only two Commissioners not eligible to attend as Old Stagers), Ald. G. Pearson (Hon. Solicitor of the I.M.E.A. throughout its career), Mr. W. L. Madgen (First Hon. Secretary of the I.M.E.A.), Ald. W. Walker (Chairman of the N.J.I.C.—Electricity Supply Industry), Mr. A. P. Trotter (Electrical Adviser to the Board of Trade throughout the early life of the I.M.E.A.).

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WESTON ELECTRICAL MEASURING INSTRUMENTS



MODEL 215.

THE WESTON
Power-Factor Meter.

The advantages possessed by the Weston Power-Factor Meter over all others are due to its superior design and construction, and the incorporation of several novel features.

IT IS EXTREMELY ACCURATE, being guaranteed to indicate the true phase angle to within 1 per cent. under all conditions of ordinary service, from 1/5 load to full load, and it is the only electro-dynamometer power-factor meter that can be used on single-phase circuits without sacrifice of accuracy.

Eddy currents, inductance, temperature, errors, etc., have been practically eliminated, and the instrument will retain its accuracy independently of load, temperature, frequency, or wave form as usually found in commercial practice.

The power consumption is extremely low, the current being only .05 amp. at full load.

Write for full particulars.

WESTON ELECTRICAL INSTRUMENT Co., Ltd.,

Telephone : *Holborn* 2029.

Audrey House, Ely Place, Holborn, E.C.1.

Telegrams : *"Pivoted, Smith, London."*

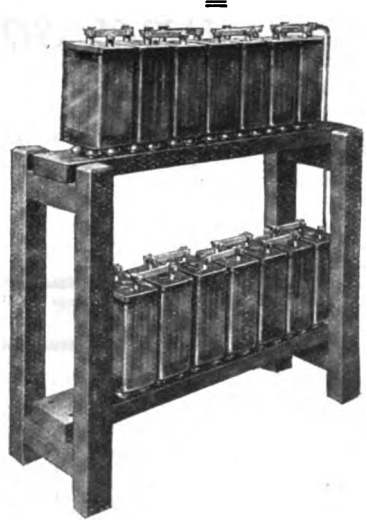
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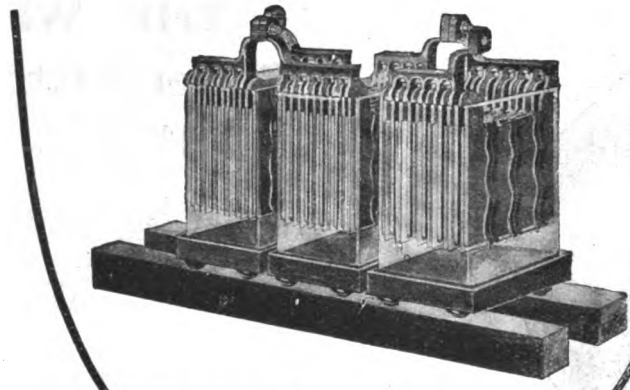
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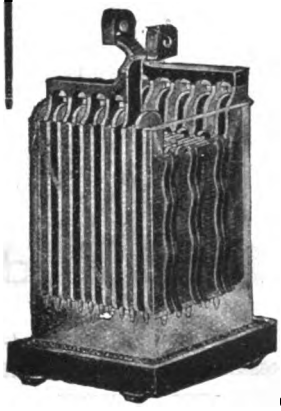
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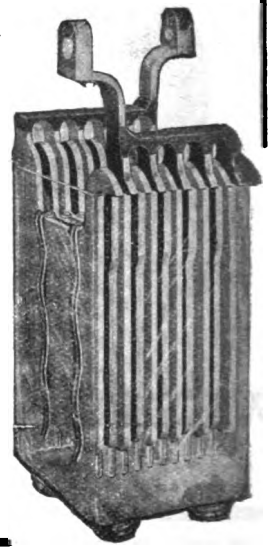
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TO OUR READERS.

ELECTRICITY is published every Friday, and, if ordered, is on sale at the principal Railway Station Bookstalls and Newsagents on that day. **It has a very large sale throughout the United Kingdom, as well as in the British Colonies and Abroad.**

The Editor does not hold himself responsible for opinions expressed by individual contributors, nor does he necessarily identify himself with their views.

Questions to which an answer is required must be accompanied by a 2d. stamp for reply. When considered of sufficient interest, the answer will probably appear in the paper.

New advertisements for the displayed columns and alterations to existing ones **must reach the publishing office not later than the first post Tuesday morning**, in order to be in time for the issue of the following Friday. This is important. Rate quoted on application. Subscription: 17s. 6d. a year, 9s. half-year, 4s. 6d. a quarter in advance, postage prepaid in the United Kingdom and abroad.

All remittances payable to the Publishers, S. RENTELL AND CO., LTD., 36-39, Maiden Lane, London, W.C.2. Telephone, No. 2468 Gerrard.

Current Topics.

Speculative Risks in Tendering.

Whilst the present downward tendency in prices of materials and labour costs is all to the general good and makes for an early trade revival, the process has its drawbacks and difficulties which are quite equal to, if not worse, than those which hindered business when the market was in the ascendant. It is always difficult to conduct business, and especially intricate business, when prices are fluctuating, either up or down, and the present unstable conditions have much to do with the bad trade and unemployment problem. There are plenty of promising schemes which will find an abundance of work for industry in the New Year if only contract prices are favourable; and with a continuing fall in the raw material and labour rates, there is no reason why stability should not soon be established and much of this long overdue work put in hand.

One of the principal difficulties in the way of reaching this happy state of affairs is in connection with tendering for large contracts which will extend over lengthy periods, and during which prices may fall appreciably by comparison with those quoted at the outset. For example, tenders are invited to-day for the execution of certain work which involves electrical plant, wiring, fittings, &c. There is much competition owing to the existing trade depression, and no doubt speculative contractors are tempted to risk much to secure such a contract. The careful contractor, on the other hand, takes every care to base his tender on exactly determined costs and market prices of materials as they exist at the actual date of tendering, contents himself with a low margin of profit, and hopes for the best.

The result is that the client, receiving so many offers of widely diverging prices, feels diffident about proceeding with the project, and in many cases, if circumstances permit, will defer action for a while in the hope that prices will come down still further. It is this lack of confidence which is militating so seriously against a trade revival to-day, and it would seem that some uniform action is necessary on the part of leading contractors in the same business, to agree on a common basis of risk in tendering. The present rate of decline in the various markets must have reached a stage where it is roughly calculable as a percentage in respect of time, and it should be possible to apply a rough formula to contracts submitted to-day, which will make for greater uniformity in tendering and thus assist in restoring the necessary confidence.

These remarks are prompted by two tenders for certain electrical work which were opened in my presence recently. Although based on a common specification which left very little room for variation as between the classes of material used, their quantities, and the manner in which the work was to be performed, the totals differed by nearly one hundred per cent. Under existing conditions, when prices are falling from day to day, one can readily understand a ten or even a twenty per cent variation, but so high a ratio as the one just cited aptly illustrates my point, especially as I know both firms to have gone very carefully into the details and to have been equally keen on securing the business.

A contributory cause of the present unsatisfactory state of affairs is the difficulty of accurate costing. A cost worked out to-day for a given job, no matter how thorough and scientific the system, cannot possibly apply to a job done a month hence, and, to tender on the basis of to-day's cost inevitably prejudices a contractor's chance of securing the business. It is here that the spirit of speculation enters into the calculations and is causing so much mischief. We do not want to revert to price adjustment clauses if it can be avoided; they seldom operate satisfactorily, and in any case involve considerable accounting and much irritation as between contractor and client. Let us stick to firm prices by all means in our power, but I counsel the various trade associations to endeavour to control the speculative factor in tenders submitted by their various members. It is only thus that confidence can be finally restored and industry revived.

When Batteries Freeze.

Some interesting facts were elicited as the result of tests carried out by the U.S. Bureau of Standards on storage cells and dry batteries at very low temperatures. The tests were made to determine the suitability of certain batteries for use in connection with Arctic exploration, and are also of interest in connection with the electrical equipment of aeroplanes for use at considerable altitudes, where the temperatures approach Arctic limits. It was found that a storage cell of the automobile type when gradually cooled down exhibited peculiar characteristics. Down to -80 degrees centigrade the voltage remained normal Between -80 degrees and -100 degrees centigrade the electrolyte increased slightly in temperature as freezing began. At -100 degrees centigrade the voltage was zero, and at a slightly lower temperature reversed its direction, rising as high as 10 volts in opposition to the normal polarity of the cell.

Violent fluctuations from -10 to + 10 volts followed a "ticking" of the frozen electrolyte. Similarly, a flashlight dry cell showed slightly higher voltages than normal at -115 degrees centigrade, reversing its polarity at -170 degrees centigrade. Currents at these low temperatures were practically non-existent, and it is also of interest to note that all the batteries tested suffered

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no deterioration in the process of freezing and subsequent restoration to normal temperatures, yielding their usual output after thawing out. Although batteries are never called upon in practice to function at such extremes of temperature as those above recorded, the results obtained are of scientific interest, as well as establishing confidence in the behaviour of such batteries when used or stored for any length of time in cold climates.

The Origin of the Telephone.

Some interesting facts connected with the early history of the telephone are recorded by a Chicago contemporary. It seems that Alexander Graham Bell, who is credited with the discovery, first came to Boston, U.S.A., to teach his father's method of visible speech in a local school for deaf mutes. The lady principal of the school impressed the Boston school board with the importance of the elder Bell's method of instruction, and after vainly endeavouring to secure the services of the inventor of the system, offered his son, Alexander Graham Bell, five hundred dollars to come to Boston and give a course of instruction at the school. He went there in April, 1871, and subsequently divided his time between teaching the theory of visible speech to the school teachers and in practical instruction to the pupils.

In 1873 he accepted an appointment as professor of vocal physiology in the School of Oratory of Boston University, and in 1875 made the discovery which led to the invention of the telephone at the age of 28. In the circumstances it is a happy coincidence that this invention should have been so widely adopted for the amelioration of the disability under which those afflicted with deafness necessarily suffer. The small portable telephone outfits for the deaf have contributed to the brightness of existence for those whose auditory organs are not altogether destroyed or absent.

1922.

To all my readers I extend the hand of friendship with best of good wishes for health and prosperity in the coming year. Let us hope that Capital and Labour will join together in working for the good of this country and, as a natural result, for their own individual good. The latter is bound to result from the former. Good riddance to 1921. 1922, I welcome you.

ELEKTRON.

Tenders Invited.—The Victorian Gov. Rys. invite Tenders for the supply and delivery of (1) 50 Track Relays, four front and two back contacts, 50 Track Relays, eight front and two back contacts, 50 Line Relays, six front and two back contacts (Contract No. 34739). (2) 100, three-position Line Relays (Contract No. 34740); (3) 100 Electric Signal Mechanisms (Contract No. 34738); (4) Electro-Mechanical Interlocking Apparatus (Contract No. 34822); (5) 50 miles Insulated Copper Wire. (Contract No. 34823). Sealed Tenders up to 15th February in the case of 1 and 2, 22nd February in the case of 3 and 4, and 1st March in the case of No. 5. Specifications may be consulted by United Kingdom firms interested on application to the Department of Overseas Trade (Room 49), 35, Old Queen Street, London, S.W. 1, until 31st December, after which date the documents will be available for those firms in the provinces unable to arrange for their inspection in London.

TEMPERATURE-INDICATING PAINTS.

In practically every engineering and industrial installation there are parts of machinery or apparatus which may usefully be covered with temperature-indicating paint, the colour of which changes when the temperature rises or falls excessively. There is thus obtained a visible indication of something amiss and the trouble may be corrected before serious consequences follow. Such an indication is particularly desirable in the case of components which are not easily accessible. If the warning is to be effective, the parts concerned must, of course, be inspected regularly, hence the paint is less effective than an audible signal would be in calling attention to the trouble. On the other hand, the mere painting of a surface is much cheaper than the fitting of any system of automatic alarms or the provision of thermo-couple temperature indicators or thermostatic temperature regulators. In many cases the best solution is to use a strip of special bi-metal sheet to close an electric contact in a bell circuit in the event of the temperature going outside predetermined limits, but there is undoubtedly a wide field of utility for temperature-indicating paints and the recipes given below are reproduced from a recent issue of the *Beama Journal* in the hopes that they may be useful to readers responsible for the maintenance of plant.

A good mixture for indicating temperature changes above and below the range 60 to 70 degrees Centigrade consists of: Copper mercuric iodide, 4 parts; silver mercuric iodide, 1 part. The ingredients are washed free from soluble impurities, dried, and finely powdered. They are then mixed to a suitable consistency with a shellac spirit varnish or with the medium used for heat-resisting aluminium paint. The "paint" thus obtained is a vivid vermilion up to 60 deg. Cent., but between 60 and 70 deg. Cent. it changes to a brown which is nearly black. If a bold disc or band of the paint be applied to the part to be protected and surrounded by an edging of white zinc paint, then the change in colour of the indicating disc or band is easily visible from a distance.

If silver mercuric iodide be used alone in the paint, the latter is pale yellow at ordinary temperatures and a vivid carmine above the boiling point of water, and can thus be used to show whether a particular component or tank, etc., is above or below a temperature of 90 to 100 deg. Cent. If the indicator paint be covered with transparent oil-proof varnish it can be kept clean by wiping down with waste.

Answers to Correspondents.

STUDENT (Lenlinfall).—Your question is not suitable for competitive replies in our Questions and Answers Competition. The subject of correct brush position for motors and dynamos is dealt with in almost any text book. We would advise you to purchase "The Practical Electrician's Pocket Book and Diary," 3s. 4d., post free from this office, or "Dynamo and Motor Attendants," by Broadbent, 4s. 10d. post free.

Meetings.—The I. E. E. will meet in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C. 2, on Thursday, 5th January, 1922, at six p.m. Lecture on "Single and Three-Phase Commutator Motors with Shunt and Series Characteristic" (with experiments), by Dr. S. Parker Smith, member. (The Lecture will be followed by a discussion.)

Preston.—The Electricity Commitee report having had an interview with the Blackburn Corporation regarding a scheme for the organisation of the supply of electricity for the Mid-Lancashire area. The Preston Councillors have recommended their Corporation to approve of the preparation of a scheme jointly by the two towns, for the whole of the area, this to be submitted to the Electricity Commissioners for their approval.

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TELEPHONE LINE WORK IN THE UNITED STATES.

By E. S. BYNG.

(*Continued from page 696.*)

(*i*) *Jointing and binding-in.*—For jointing hard-drawn copper wires, a copper sleeve (McIntyre) is almost universally used in preference to a twisted and soldered joint. For galvanised iron wire, steel tubes are used, but it is also standard practice to twist and solder. At straight-through insulators a piece of soft wire of the same material as the through wire is used for tying-in and binding the line wire.

(*j*) *Termination of open wires on poles.*—At distribution or opening-out points circuits are terminated on straight insulator pins. On exchange circuits No. 18 B. and S. (26 lb.) insulated bridle wire is used for terminations and cross-connections. On high-grade toll circuits a No. 14 B. and S. (65 lb.) insulated wire is used. In both cases the covered wire is supported underneath the arms in small bridle rings. Prevention of leakage on high-grade toll circuits is effected, wherever bridle wire is used for terminating purposes, by the interposition of an additional insulator (made of a material known as "electrose") in conjunction with the glass insulators. The bridle wires are threaded through the metal tube inserts and soldered at the top, thus sealing the holes as shown in Fig. 4.

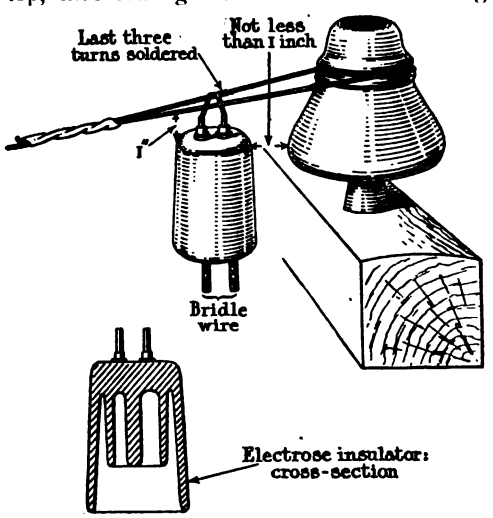


FIG. 4.—TERMINATION OF HIGH-GRADE TOLL WIRE, USING ELECTROSE INSULATOR.

(*k*) *Superimposing.*—On a toll or long-distance line practically every pair of physical circuits is used to obtain a third or phantom circuit by the installation of repeating coils at the terminating ends. The phantom circuit has been proved to be a better circuit than the side circuit, and is, therefore, a very profitable proposition. A further utilisation of the plant is obtained by each of the four wires forming a group being separately composited for telegraph operation. A still further development is that by the application of "carrier" currents, each pair of wires can be utilised for several simultaneous telephone or telegraph circuits. This advancement in the art greatly increases the value of open-line plant, but necessitates a high degree of efficiency in its construction and maintenance.

(*l*) *Transposition.*—All open-wire circuits in America are run straight. Only one arm is therefore required on a pole route which carries five pairs of wires. A system of transposition is adopted for long distance lines. Two methods of transposition have been worked out in a very thorough manner, one for "exposed" and the other for "unexposed" lines.

Apart from this method of avoiding electrical interference, measures are frequently suggested to the electric supply companies by the telephone companies for the elimination of the higher harmonics which, from time to time, cause serious electrical interference with telephonic speech. Each cause of trouble is studied as it arises, and the endeavour always is to reach an arrangement which is mutually satisfactory and compatible with economy.

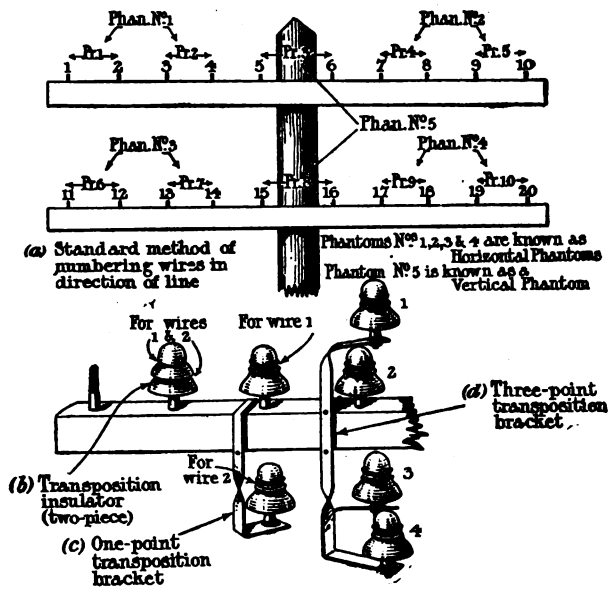


FIG. 5.—NUMBERING OF WIRES, AND TRANSPOSITION BRACKETS.

The standard numbering of wires on a pole route of two 10-wire arms is given in Fig. 5 (*a*). Wires 5, 6, 15 and 16 comprise what is known as the "vertical phantom circuit."

For a single-circuit transposition on an ordinary toll or long-subscribers' circuit a special type of transposition insulator is used. It consists of a 2-piece insulator, each piece having a groove. A special 9-in. transposition pin carrying two sets of threads is necessary to provide sufficient clearance above the cross-arm.

On a high-grade toll circuit a bracket is fitted to carry the second wire. A special method of transposition is

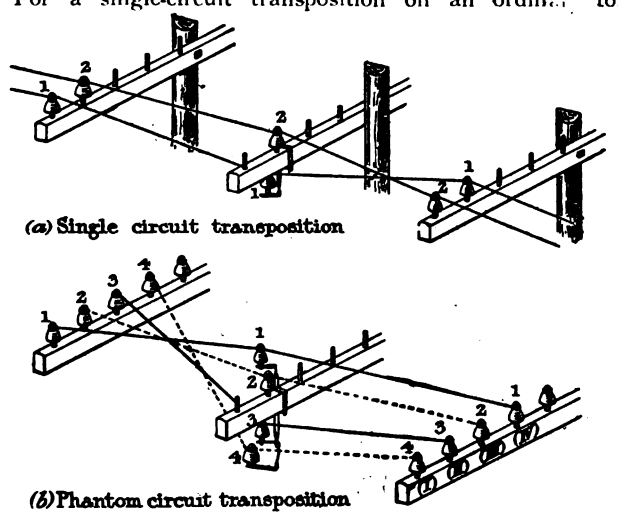


FIG. 6.—METHODS OF TRANSPOSITION.

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employed on lines which are included in a phantom group. Not only must the wires in the original metallic connection or side circuits be transposed, but the phantom circuit must be balanced by transposition against its own side circuits as well as against other phantom circuits on the same pole. A 3-point transposition bracket has been devised for this purpose. The three methods are illustrated in Fig. 5 (*b*), (*c*), and (*d*). One method in which transpositions are made on side circuits and phantom circuits is shown in Fig. 6.

There are eight combinations possible for transposing the four wires forming a phantom group. The actual type of transposition and location in relation to other circuits is decided for each route after survey. When the wires are erected by means of a running board the pairs can be transported separately, or the position of the pairs changed for a phantom transposition simply by releasing the spring latch on the eye to which each pair is attached.

(*m*) *Loading of open wires.*—Until the advent of the repeater, the practice of loading long-distance lines was adopted in America for circuits using No. 8 B.W.G. and No. 12 N.B.S. copper. In the case of existing No. 8 B.W.G. circuits, where repeaters have since been installed, the loading coils have been removed, that is to say, the wires have been "unloaded." In the smaller size of wire, however, loading coils are required and are still being fitted in conjunction with repeaters. A complete unit of loading, which consists of three coils, two for the side circuits and one for the phantom, mounted in a pot suitable for fastening to the pole, is used in conjunction with a lightning arrester to protect the coils.

(*To be continued.*)

Questions and Answers by Practical Men.

RULES.

QUESTIONS: *We invite our readers to send us questions, preferably on technical problems that have arisen in actual practice. Questions which we consider of sufficient interest to our readers will either be replied to under "Answers to Correspondents" or replies will be invited from our readers. One shilling will be paid for the question which we select for competitive replies in this column.*

ANSWERS: *A fee of 10s. will be paid for the answer which we consider shows the greatest merit, and 5s. for the one we select as second best. In judging the replies, importance will be attached to clearness and conciseness, as well as accuracy. The Editor reserves the right to make no award, or to accept only one reply, if, in his opinion, the answers received do not possess sufficient merit. Competitors desiring the return of their manuscripts, if unaccepted, should enclose stamped addressed envelope.*

Write on one side of the paper only, and if diagrams are sent, draw them on a separate sheet of paper attached to the manuscript. Competitors may adopt a "nom de plume," but, both in the case of questions and answers, the competitor's real name and address must be sent with the manuscript as a guarantee of good faith. No correspondence will be entered into with regard to successful replies. The Editor's decision is final

Commencing with Question No. 101, a Diploma of Merit will be awarded to the six competitors who win the first or second prize the most times during the next twelve months.

The words "Questions and Answers," or "Q" and "A" should be placed at the top left-hand corner of all letters intended for this column.

QUESTION NO. 131.

I wish to purchase a 10 ampere prepayment meter for use on a 220-volt D.C. supply. Can any reader advise me upon the best type to buy? I would like a few details about its operation and the necessary precautions to be taken when fixing it.—"WIREMAN."

QUESTION NO. 132.

How do the time limit relays operate on the London and South Western Railway traction units? I understand that the function of these relays is to regulate the period of closing of the main circuit contactors.—"RAIL."

Replies to Questions Nos. 131 and 132 must be received by January 21, 1922.

Answers to Questions.

QUESTION NO. 127.

I desire to have electric light and electric motors fitted in my boot factory. I would like you to point out the most essential features to be considered when drawing up a specification to enable the correct type of motor and fittings to be installed. The supply is 500 volts, three wire.—"Astatic."

REPLIES TO QUESTION NO. 127.

The first prize (10s.) has been awarded to S. J. Berryman, Gustavus Road, Cambourne, for the following reply:—

Seeing that the boot factory is supplied with current at 500 volts on the three-wire system the most suitable voltages would be 250 for lighting and 500 for power. Before deciding on the size motors to install an important point to be considered is, if each machine is to be driven individually by a small motor, or if the group system is to be adopted, this being large motors to drive a line shafting, from which each machine is driven by a countershaft. Both methods have their advantages and disadvantages.

In the first case the outlay would be large if many machines are to be operated, but it has the advantage that any one machine may be used independent of the others, also a breakdown of one motor would not interfere with the operation of the other machines.

In the second case, when a motor driving a line shafting is used, it has the advantage of a smaller initial outlay, but the disadvantage being should a breakdown occur with the motor, all the machines driven from that particular shaft are thrown idle, which may occur when an important machine is required to be kept working. This method requires countershafts, bearings, belting, oil for lubricating bearings, and either clutches or belt shifting gear for starting and stopping each machine, which would cost quite a bit and would not be required in the case of individual drive.

When considering the type of motor to be used, the shunt wound is the most suitable, as its speed is constant on all loads; also the totally enclosed or pipe-ventilated type should be used in order to prevent the leather dust from the machines entering the windings.

The switchgear for controlling the motors should consist of a double pole switch, double pole fuses and starting resistance, the starting resistance to contain a no-volt and overload release. In some self-contained starters, fuses are dispensed with, the double pole switch being held in position by electro-magnets instead of a spring. Should an overload occur, or anything happen necessary to break the circuit, current is cut off from the electro-magnets, which, of course, releases the switch. The trouble of putting in new fuses or changing the fuse holders is thus done away with.

The advantage of using the 500-volt circuit is that it is only necessary to have cables of half the cross-section of that required if the motors were put on the 240-volt circuit. For practical purposes it is calculated to allow 1.7 amps per horse-power for 500 volts and 3.4 amps. per horse-power for 250 volts, thus a 12-h.p. motor on the first-named voltage should be connected up with cables capable of carrying 20.4 amps., but if the 240-volt system is used the cables would be required to carry 40.8 for the same horse-power.

To obtain 500 volts from the main cables, connection should, of course, be made with the outers, the 250 volts being derived from one outer and the neutral, or middle wire, as it is sometimes termed.

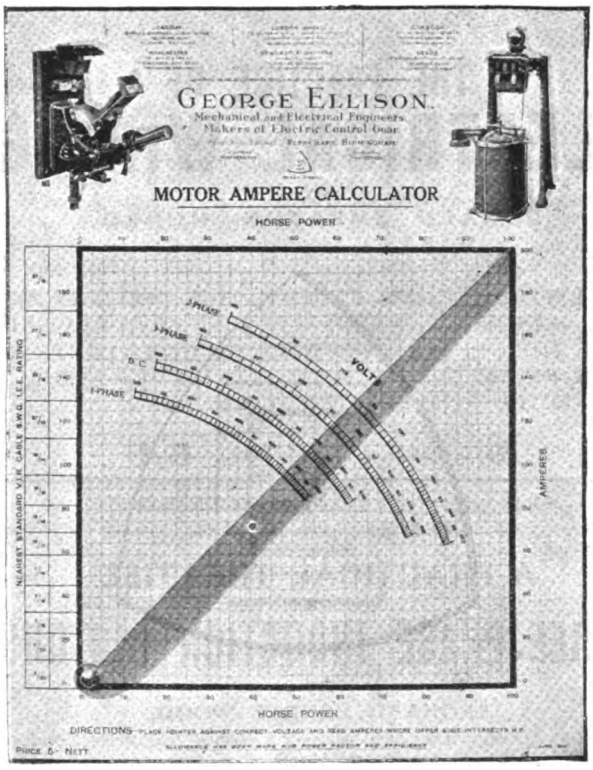
With regard to the lighting of the building, there are a good many systems to select from. (1) The old-fashioned capping and casing which is almost obsolete; (2) open wiring, which consists of insulated wires run on insulators; (3) conduit system; (4) one of the many lead covered types now in use, this being easy to install and may be used under almost any condition.

The next point to be considered is: Is each machine to have its own lamp or point, as it may be termed, or is the shop to be lighted with large lamps from the roof or ceiling, or perhaps using both? If the first-named is to be adopted it would be an advantage to fit switch lampholders to each machine, making it possible to cut down lighting expenses on machines that are not in use. Enamel shades should be used, these being an advantage to the operator and will stand a lot of rough usage. When choosing lamps

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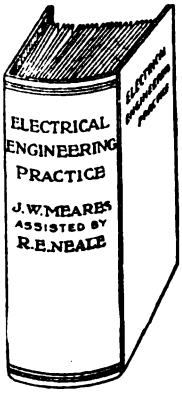
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for individual machine lighting, the vacuum lamp has first place, of coures, both for light and economy in consumption. Although the carbon lamp may be cheaper to buy, it would be the more expensive taking everything into consideration.

For roof or ceiling lights the arc lamp, Cooper-Hewitt, and such types, must, I think, take second place to the present-day gasfilled lamp, which does away with the trouble of carbons or any necessary starting arrangements. I might also add, the motor cables may be run on insulators when in positions not exposed, conduits being used from the starter to the motor.

When laying down a plant of this description, especially in the present unsettled state of trade, the outlay is a thing to be considered, and "Astatic" will be able to see which system will suit his requirements the best.

The Second Prize Winner's reply will be published in due course.

BRITISH WATER RESOURCES.

FINAL REPORT OF COMMITTEE OF INQUIRY.

The Inter-Departmental Committee which was originally set up by the President of the B.O.T. in June, 1918, to examine and report upon the water-power resources of the U.K. from the point of view of industry, has now issued its Final Report.

The broad results of the Committee's inquiries are as follows:—They find that in Scotland, especially the Highlands, the natural conditions are such as to facilitate the production of power. In this area the bulk of the larger water powers of the British Isles is situated, and although it is remote from the present industrial centres, no part of it is far from the sea or the Caledonian Canal. The larger water powers of Wales are situated in the north-western portion of the Principality. As compared with the Scottish water-power resources, the cost of developing the larger of the Welsh resources as separate schemes would usually be high. While there are several schemes worthy of careful consideration on an individual basis, it would be desirable to consider the development of a number of the less favourable as adjuncts to other more favourable schemes. As in the case of Scotland, there are numerous sites capable of developing small blocks of power. As regards England generally, the main sources of water-power are the small falls on the rivers. The Committee consider, however, that the aggregate output from these sources could be materially augmented by installing modern plant, replanning existing sites, and generally improving the watercourses. In Ireland, a certain amount of power can be developed from high-level lakes in the mountainous areas, but the main sources of water-power are to be found in the rivers. It is generally considered that the utilisation of the water-powers of the U.K. would tend to relieve the increasing congestion of our large centres of population, and in the case of the Highlands of Scotland would assist materially in improving the present low standard of comfort of the inhabitants of that area, and thus arresting the abnormal emigration from it. The potential water-power of the schemes before the Committee (not the total available) was estimated at 194,965 kw. (continuous) in Scotland, 35,900 kw. in Wales, and 20,440 kw. in England. The Irish Sub-Committee made an estimate of 280,000 kw. (continuous) as the total available potential water-power in Ireland. It was further estimated for G.B. that probably 210,000 kw. (continuous) could be developed at an economic rate. This was given as the equivalent in energy of nearly three million tons of coal per annum burnt in steam plants.

In the Committee's Third Interim Report (Cmd. 1079, 1st Dec., 1920) their conclusions and recommendations for utilising the tides of the Severn Estuary were fully set forth. A scheme was considered for producing by tidal-power of the Severn 260,000 kw. throughout a day of ten hours, and for an annual saving by this means of from 1¼ to 2½ million tons of coal. They recommend that a Special Technical Commission should be set up to investigate the whole question as a commercial proposition and with special reference to the Severn Estuary.

The Committee recommend that in view of the importance in the national interest of the utilisation of water-power wherever this is commercially practicable, the B.O.T. or the Electricity Commissioners should be charged with the duty of studying, supervising and promoting the development of all water-power.

SOUTH WALES ELECTRICAL ENGINEERS.

Mr. A. C. McWhirter, Chairman of the Western Centre the I.E.E., in his address at the Engineers' Institute, Cardiff, declared that the present year ought to be memorable in the history of the institute, for it was its jubilee year. Started in 1871 with a membership of 66, it had grown steadily until now it could boast nearly 10,000 members. In this, its jubilee year, great honours had been conferred on the institute, for the Royal Charter of Incorporation had been granted by His Majesty the King, who had also intimated his willingness to become a patron. Started in 1912, the Western Centre had made good progress, its inaugural membership of 213 having grown to 421, though there were several eligible electrical engineers in the area who were not as yet incorporated, and who should be urged to join up. The president, in surveying the trade, called attention to the work of the contracting centre of the institution and urged that established firms should be supported in their endeavour to work against the crowd of nondescripts who had nothing at stake but who styled themselves electrical contractors. The Electrical Contractors' Association was endeavouring to raise the status of the electrical contractor to a higher standard, and the assistance of all who placed orders for contracting work was required to bring this about. Only responsible firms should be employed. The association was hopeful that in the near future contractors would require to be registered and he believed their institute would welcome and support such a reform. He was absolutely opposed to municipal trading and failed to understand why municipalities should be allowed to compete with their ratepayers.

Reviews of Books, &c.

[Books noticed in this column will be sent from ELECTRICITY *Office to any part of the world, for the published price, plus ten per cent. for postage (minimum 2d.), and orders will be appreciated.]*

THE BOOK OF THE FORD. Sixth Edition. (Temple Press. 3s. net.)—Yet another edition of this popular handbook has just been issued. It is a completely revised, fully illustrated and enlarged edition which the author, Mr. R. T. Nicholson, has been at great pains to render as comprehensive and up to date as possible. It is undoubtedly the indispensable handbook for the Ford owner, and is equally of service to the experienced hand as to the novice. Stated briefly, it is a compact encyclopædia of practical information on the driving, management, upkeep and repair of the Ford car, written in such simple language that the veriest tyro cannot fail to follow it and benefit from the information. Every detail of the car is discussed in the numerous chapters of the book, and it would be difficult to specify anything in the way of hints or adjustments to any particular part of the Ford car that is not dealt with. The later Ford cars differ in various important respects, such as the adoption of the left-hand drive, which has altered the disposition of various parts. Then there is the complete electric lighting and starting equipment now embodied. These changes are fully dealt with, in addition to the full information about the earlier models. There are many new illustrations, and an exhaustive and very convenient index to the numbered paragraphs.

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THE MECHANICAL HANDLING OF GOODS. By C. H. Woodfield. 116 pp. 73 figs. (Pitman. 2s. 6d.)—Little need be said about this publication excepting that it is one of the "Pitman Primer" Series, and keeps up the reputation of the series for general clarity and conciseness. We have read every word of the book under review, being fascinated by the really wonderful amount of useful information so interestingly squeezed into 113 pp. Besides the student and general searcher after knowledge, all owning, or in charge of, factories, docks, warehouses, stores, etc., should refer to this Primer for points on the economic handling of goods and materials.

Various Items.

Diaries.—Messrs Keighley Gas and Oil Engine Co., Ltd., of Imperial Works, Keighley, are again issuing their useful daily calendar mounted on a stout cardboard base, which reproduces an excellent view of one of the company's engines.

To Procure Foreign Trade.—Mr. E. W. Petter, Chairman of the British Engineers' Association and Managing Director of the firm of Messrs. Vickers-Petters, the well-known oil engine experts and manufacturers, is on the point of departing to India to see what he can do towards helping start the wheels of industry in the direction of securing orders for his firm.

Domestic Labour-Saving Competition.—A competition open to all women, irrespective of nationality, has been organised by the Women's Engineering Society, of 26, George Street, Hanover Square, W. 1. The Competition is divided into three sections: (a) Engineering device suitable for mech., elec. and automobile work, etc; (b) structural improvements; (c) any other labour-saving appliance for the home. All models, drawings, etc., to be in by March 31 next. Prizes of 7, 5, and 3 guineas are to be awarded. Particulars from address above.

Transformer Abstracts.—No 2 of this series of booklets has now been issued by Johnson and Phillips, Ltd. (Charlton, S.E. 7). It deals with the particulars required with enquiries so that the specification and tender can be got out in a minimum time. The matter is gone into most fully and clearly, and together with an able explanation of the behaviour of transformers with varying ratios of iron and copper losses, and some notes on voltage adjustment, overloads, etc., makes the booklet a really useful one. We are filing our copy for future reference and counsel all who obtain one to do the same.

Meetings.—The I.E.E. (Wireless Section) will meet in the Lecture Theatre of the Institution, Savoy Place, Victoria Embankment, W.C., on Wednesday, January 4, 1922, at 6 p.m. Paper: "High Speed Wireless Telegraphy," by Lieut.-Col. A. G. T. Cusins, Royal Corps of Signals. A demonstration on Traffic Working will be given by the Author.——The Junior Inst. of Engineers will meet on Friday, 30th inst., at Caxton Hall, at 8 p.m. Questions and general discussion. Also on Friday, January 6, at 8 p.m. Lecturette: "Stone and Marble-Working Machinery," by A. E. Bingham (Member). Slides.

The Crystal Palace School of Engineering.—General Sir Edward Raban, K.C.B., R.E., late Director of Works to the Admiralty, addressing the students of the Crystal Palace School of Engineering last week, said they were living in difficult times, and there was a deficiency of work in civil engineering. He advised students on leaving to take any class of work under a contractor, to gain experience. He also argued strongly the importance of young engineers making clear and good reports of work in hand, because those employing them often had no windows out of which to look upon the work. Young engineers had no idea how the ability to write a good report would help them in their profession. This fact was much impressed upon him by a visit last week to the reconstruction work in process in Belgium.——The "Wilson" Premium for the best paper read before the Crystal Palace Engineering Society during the past session, has been awarded to Mr. B. W. Rowe, for his Paper on "Road Construction." Other papers read, and discussed during the session were: "Electric Traction," by W. A. Reynolds; "The Ruby Mines of Burma," by E. N. Wemyss; "Sewage Disposal," by D. M. Cameron; "Refrigerating Machinery," by E. A. Wheeley; and "Water Power," by T. L. Bowring. The Premium was presented to Mr. Rowe by General Sir Edward Raban, K.C.B., late Director of Works to the Admiralty, on the occasion of the 147th distribution of certificates, at which he presided, on December 21.

"Electro Harmonic Smoker."—The concert which was held at the Great Hall, Cannon Street Hotel, on Friday, 16th inst, was voted a great success. It was well attended and the change in the position of the platform rendered it possible for a larger number of those present to hear the artists distinctly and clearly. The next Smoker will be held early in January, and we hope it will be equally well attended.

"The Outline of Science."—In Part 4 of this magazine (Newnes), a large portion of the space is devoted to an account of the ascent of man from the primitive type to the present day, including reproduction of the paintings and drawings which were made in caves by our predecessors and ancestors. Chapter 6, is headed "Evolution" which is still going on, and describes the progress made by birds, beasts and fishes in their respective stages of growth, while chapter 7, deals with the Dawn of Mind, and with articles on the senses of fishes and their interesting ways. The illustrations throughout are of high order.

Society of Engineers.—At the annual general meeting held on the 12th inst., the following premiums for papers read during 1921 were awarded:—President's Gold Medal to Mr. G. O. Case for his paper on "The Winning of Tidal Lands in British Guiana." Bessemer Premium to Mr. R.W.A. Brewer for his paper on "Some Modern Engineering Practice in America," value £5 5s. Nursey Premium to Mr. Alfred S. E. Ackermann for his paper on "The Physical Properties of Clay" (3rd paper), value £3 3s. Society's Premium to Mr. W. M. Beckett for his paper on "Northwick Sewerage and Sewage Disposal Works," value £3 3s. Geer Premium to Mr. C. F. Moore, of the Crystal Palace Engineering Society, for his paper on "The Locomotives of the London and North Western Railway," value £5 5s. (open only to members of Associated Societies).

Trade Notes.

Our columns have borne witness on many occasions to the enterprise of the **General Electric Co., Ltd.,** particularly have we in mind at the moment their Sales Campaigns to popularise good lighting, "Magnet" heating and cooking appliances, and other domestic labour savers. Besides advertising, window displays and the provision of suitable literature, posters, price-tickets, etc., of continued interest, the company have seized the opportunity offered by the Season of Gifts to stimulate further the popular demand for "Magnet" appliances, thus adding another link to the chain of their co-operation with the trade, included being a wide circularisation of an attractively produced leaflet giving some practical suggestions for electrical gifts for Christmas and the New Year. The trade would be well advised to take notice.

We have received from **Bell's United Asbestos Co., Ltd.** (Southwark Street, S.E. 1), a folder drawing attention to various forms of asbestos for electrical insulating and fireproof purposes, the company claiming to be the pioneers of the world's asbestos industry.

British Insulated and Helsby Cable, Ltd. (Prescot, Lancs), have just issued a new bulletin dealing with Prescot aluminium matting and sections, also aluminium and copper sheets. The company were among the first to put aluminium matting on the market, and as is, of course, known, it is now very extensively used for many purposes.



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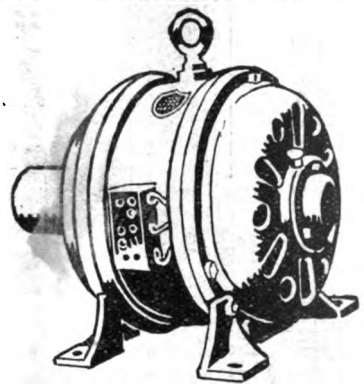
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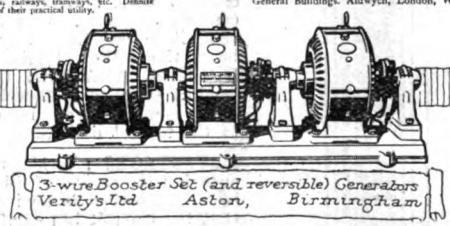
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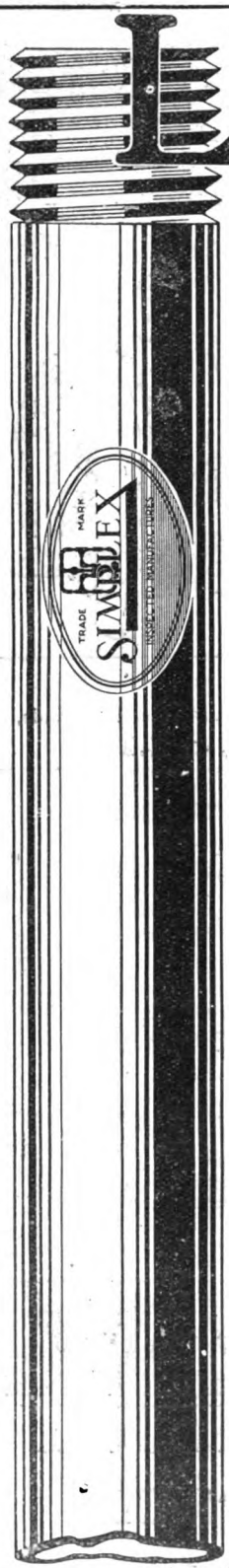
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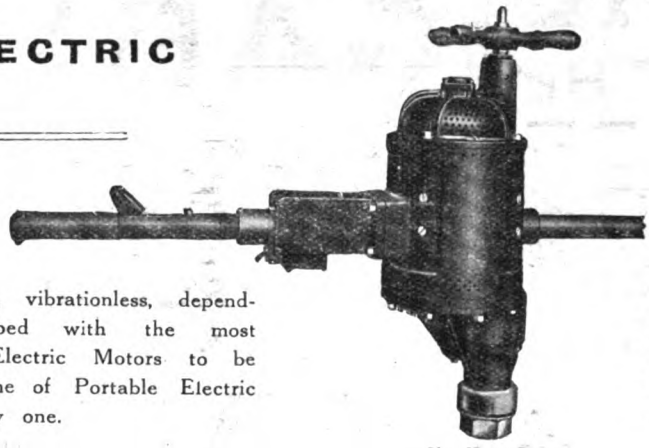
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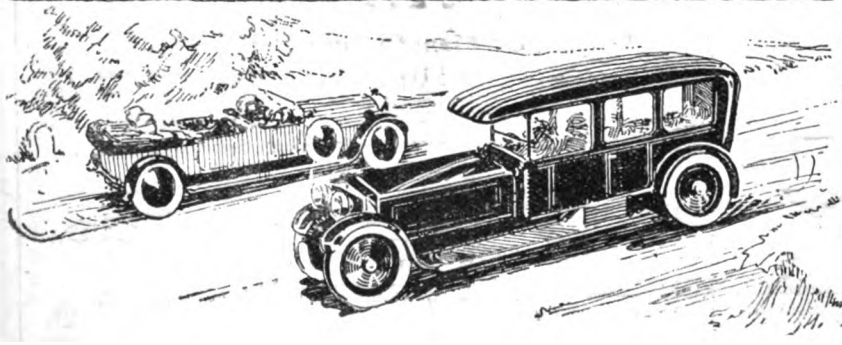
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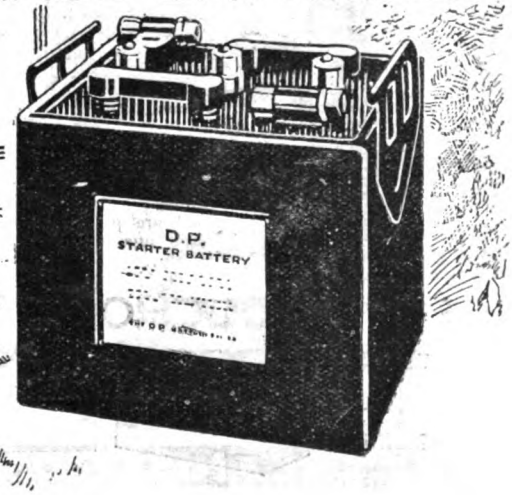
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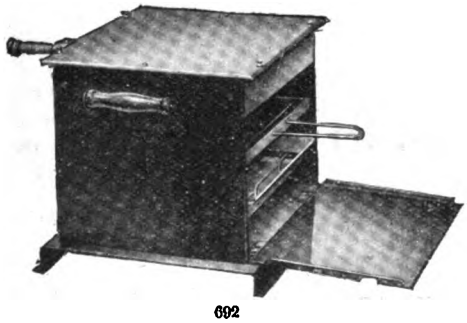
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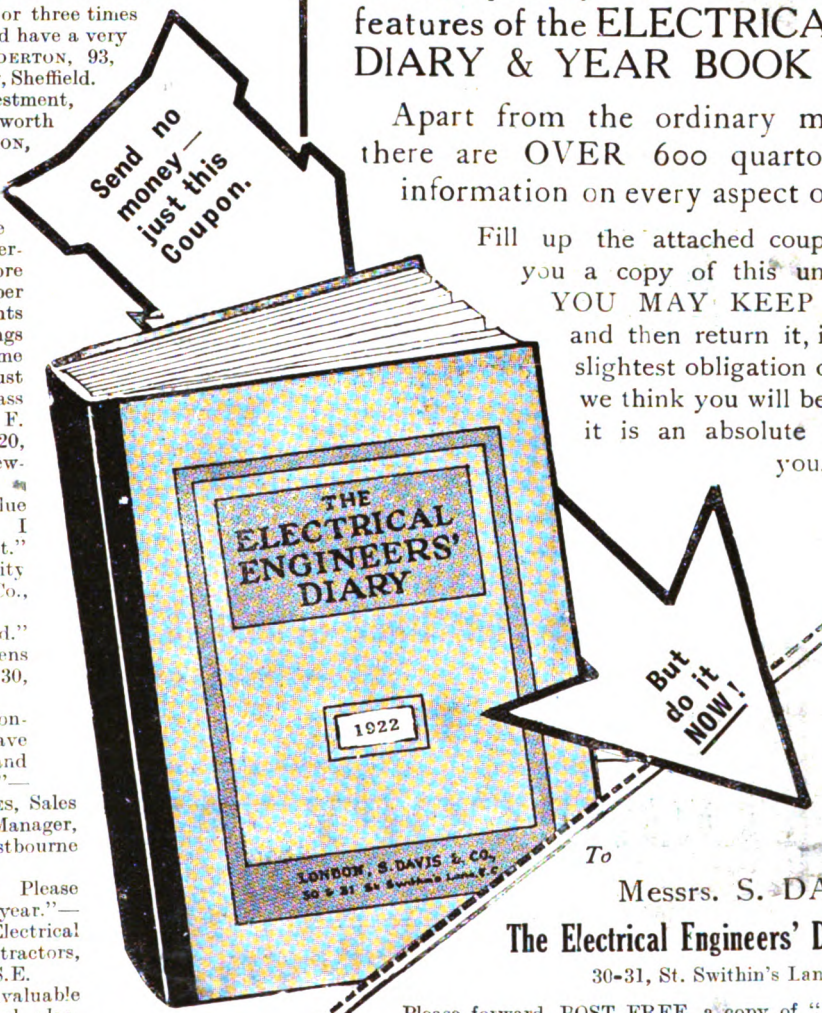
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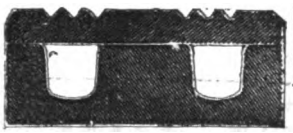
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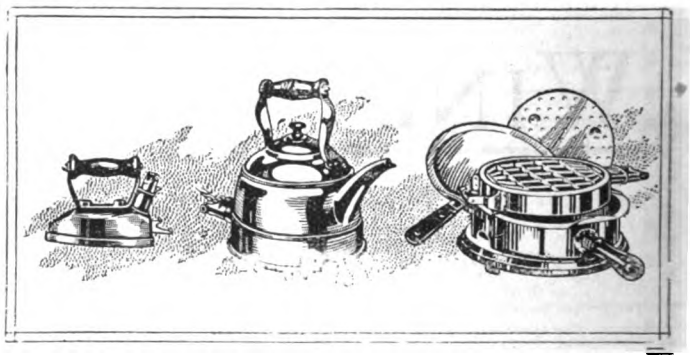
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